DISCOVERY

A Monthly Popular Journal of Knowledge

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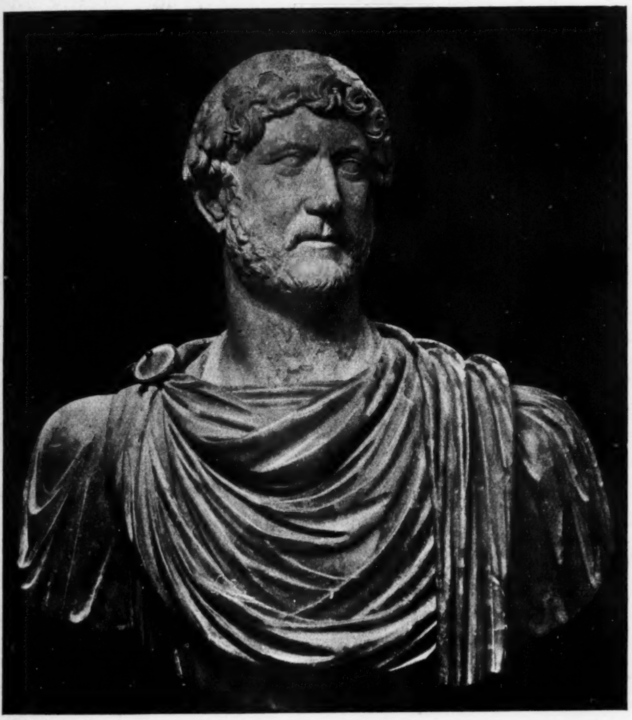

THE BUILDER OF THE WALL.

CONTENTS

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Vol. V, No. 53 MAY 1924. PRICE 1s. NET

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Editorial Notes

Readers who have followed the career of Discovery will note with regret the disappearance of Mr. R. T. V. Pulvertaft from the editorial chair. It is due to a combination of circumstances. Firstly, and mainly, he has accepted an important appointment on the staff of St. Thomas's Hospital which prevents his giving full time to the task of editing this paper. Secondly the paper, now entering upon a phase of expansion, needs the services of an editor who can give to it the time it requires. These are sound reasons.

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Still, I do not know that many readers know what a debt of gratitude they owe the late editor. Not only did he labour through those difficult periods when the continuity of the journal was threatened, but he has been responsible for an astonishing amount of the best work that has appeared in its pages. He wrote, he reviewed, and he hunted out subjects and writers and gave a loyal whole-souled energy to the paper, not as a job but as a cause.

He will continue to contribute to our pages and to act in an advisory capacity.

* * * * *

There are one or two other points connected with recent changes which may be of interest to readers. Firstly policy. This you will be glad to know remains unchanged. Discovery will continue to present to its readers specialised expert knowledge written in a clear and popular manner. We shall strive to keep the present high level even including some of those features which though written down to the level of the general scientific reader, are of necessity rather beyond the ordinary man. We are, however, going to increase the quantity of articles and the increase will be in the main more popularly treated matter.

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The reason for this is that a paper which deals too expertly or in too specialised a manner with its subject matter preaches only to the converted. We wish to popularise scientific knowledge and therefore must consider proselytising no less important than preaching to those already within the fold. So if you are "high-brow" and feel that such and such article is really too elementary, have mercy on us, similarly if you are "low-brow" and feel pardonable irritation at our inclusion of an article that requires herculean effort to comprehend—again be merciful and remember that if you read Discovery for a year you will probably come to like and understand this rather difficult kind of article.

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We welcome suggestions and articles and we want new writers and new readers. The future development indicated above may take an issue or so to accomplish, but it represents the considered policy of all connected with the management of the journal.

* * * * *

There is an old myth in Fleet Street that every paper has a hidden skeleton and that every office is haunted by its particular ghost. It takes many shapes for on one big daily it is said to be a chauffeur's wife, on another a city typist, a third is haunted by a harassed little suburban business man. Even the respectable precincts of a big Church newspaper do not escape a malignantly anti-ritualistic spook.

This ghost, in whatever form it manifests itself, is always the same essence. It is the lowest common denominator of the readers of the paper and it expresses itself with the time honoured editorial formula "We can't put that in. Its good stuff—but it is miles above the heads of our readers."

* * * * *

It is this factor which obliges the lighter dailies to treat scientific developments on sensational lines. Unless the "story" will bear such an interpretation it is of little use to them for they believe that their readers would not be interested other than in the sensational side. The scientist grumbles at the papers. He assumes that their function is to educate the public. This, though in every way desirable, is not the main purpose of a commercial newspaper run in competition with other journals and an honest newspaper man will state quite frankly that the duty of a newspaper man is to provide an attractive and saleable paper full of news, and that educating the public should be done by the people paid to do it.

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Discovery exists to bridge the gap between the specialist in knowledge and the public and it, like any other paper, has of necessity its average reader and its lowest common denominator. We presuppose in the reader of Discovery a certain amount of general education, but unfortunately there is no precise term which expresses them. The "general scientific reader" is a loose phrase at best and has been badly used at the hands of publishers so that it conveys no precise standing. Terms like "layman" or "man-in-the-street" are also inapplicable for the man-in-the-street may convey to one mind a mental picture of a man laying gaspipes, while the next mind images a dapper business man on his way to the office, two types widely different in their permeability to scientific ideas.

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No, we need a definition, something that can be expressed concisely in a few lines and which will serve to define an average reader of Discovery clearly enough to indicate to an author or contributor the type of person he is writing for, and what elementary knowledge he may safely assume to be possessed.

* * * * *

Here I call on readers of Discovery to help in establishing this very necessary datum line. Can you send me within the limits of a postcard suggestions on a standard reader definition. It will be very useful as guidance and it will also prove a pleasant exercise in clear thinking.

The lowest common denominator I have already heard from. He is keen on science and "all that sort of thing," and requires advice on making a crystal set in a cigar-box. He is under notice to leave and will be replaced by the most suitable bogey that appears in your card vote.

* * * * *

Parallels between Wembley and the Great Exhibition of 1851 will probably have appeared in many columns before these notes are in print. Yet it is no bad thing to look back to those past days when science was still pottering speculatively about among simple relationships which are taught to school-children to-day. The impulse of that period lasted through two generations and we owe a peculiar debt not only to the commercially applied arts and inventions but to the "scientific potterers" who mused and supported the "popular" interests of those days.

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We still see relics of them, the tottery old Society of Arts microscope with objectives casting rainbow hues round every object looked at. Derelict cases of stuffed Australian beasts, bead-eyed wallabies and a pathetically flattened duck-billed platypus. The cylinder electric machines and static apparatus that delighted scientific families in the days of crinolines have mostly gone and with them the collections of fossils and unclassified oddments. Ethnologists may yet find rare prizes among savage gear ruthlessly collected by Victorians and as ruthlessly consigned to the lumber room by Edwardians.

* * * * *

Yet, with all the childishness of it, as we might say to-day, when everyone specialises in some precise branch of knowledge—what a glorious time they had, just pottering—and what a mighty legacy they have left us. Desire for knowledge fed with the curious old red popular manuals on Electricity and Magnetism, Buckland's "Curiosities of Natural History" and other kindred books of the period may have shaped the interest and decided the careers of many of the last generation, the successors to the class of '51. We owe a debt to the popular writers of those days who took the plain facts of science, facts then not too easy for average comprehension and made them intelligible for the amateur.

* * * * *

They did more, too, they conveyed in some elusive manner a spirit of inspiration, a keen appetite for further knowledge and for deeper thought. It is that note which we must strive to strike again to-day, the note of challenge of thoughtful search—and of Discovery.

Secret Societies Revived in Modern Germany.

By R. B. Mowat, Fellow and Assistant Tutor of Corpus Christi College, Oxford.

The Government of Germany is but a figure-head. The real power is in the hands of the network of secret organisations which control German public opinion. More than a century ago German secret societies rebuilt their nation after the defeats of the Napoleonic wars. Will they succeed again or will the Communist societies vanquish the nationalist societies? The future of Western Europe may be dependent on these issues.

Circumstances in Germany after the War of 1806 and after the War of 1914-18 were in many respects very similar. On both occasions Prussia went to war, glowing with military pride and filled with high hopes. In 1806 Germans had behind them the glorious memories of the reign of Frederick the Great; in 1914 they had the still living and developing tradition of the brilliant Empire founded upon the victories over France forty-four years earlier.

The War of 1806 resulted in a terrible shock to the Germans' self-respect and to their sentiments of pride and glory. The *débacle* of Jena seemed to remove the solid ground from under their feet. The result was a feeling of disillusion, an outburst of demoralisation in German society. The philosopher and publicist, Fichte, observed with grief and pain the demoralisation in social life in Berlin, the extravagance, the recklessness, the indifference to the public interest, in the years immediately following the battle of Jena.

Result of Calamity.

So it was after the fatal campaign of 1918. The great military Empire had fallen. The magnificent institution to which the Germans had pinned their whole faith had, in the end, proved helpless to protect them. The carefully fostered ideals of half a century were shattered; and in the consequent disillusion the old social bonds were relaxed, the old careful German ways were abandoned, recklessness, extravagance, vice are said to have become common in the life of all the great cities.

When such a condition of affairs manifested itself in Prussia and other German States after the War of 1806, the more thoughtful and public-spirited people—the statesman, Stein, the teacher, Fichte, the soldier, Scharnhorst—set themselves to the task of reviving the German spirit, of rekindling national sentiment, of restoring and renewing the machinery of the State which had failed under the test of the War. There were three ways by which the energetic and public-spirited among the Germans tried to restore the national spirit and strength, and to prepare the people for the day which they were certain would come for once again measuring their strength with that of their conqueror. The three ways were, firstly, administrative and military reform: this was the work of Stein and Scharnhorst. The second, was educational and literary: this was the work of Fichte, the philosopher, Niebushr, the historian, Gentz, the supreme journalist or "publicist"—these and a host of others. The third method for restoring the national spirit and strength was secret societies, of which the best known was the famous *Tugendbund* or Union of Virtue, which had a branch or unit in every University, and perhaps in every town in Germany.

Historic Parallels.

Secret societies appear to have arisen in every German State, and the French authorities in the occupied and protected teritories became seriously concerned at them. In the "Reports of the Army of Germany" (i.e. the French Army of Occupation) deposited in the *Archives Nationales* (AF. iv. 1657) at Paris, there is an informing Memorandum from General Gersdorff to Marshal Ney. The Memorandum is dated from Dresden on December 29, 1811. It describes in particular three secret societies: the Union of Virtue (*Tugendbund* or *Tugendverein*) "which has its seat in Prussia and at the head of which are the Princes of the House (of Hohenzollern) and the most distinguished generals." Secondly, a society called *La Concorde,* "which has its origin in Hanover and which has many off-shoots in Westphalia"; and finally, "the Society for German Right and Fidelity (*die Gesellschaft fur deutsches Recht und Treucs*) of which the majority of members are in the Austrian dominions." Besides political societies there were a large number of associations, quasi-political, for practising gymnastics or physical drill.

The years 1919-24 have witnessed a revival of Secret Societies, similar to those of 1806-12, and for similar reasons. They are the agencies by which earnest people seek to restore the German spirit and strength after the disasters and demoralisation of 1918-19.

It is very difficult to define the term "secret society." Technically, it ought to mean an association, which is unknown to the law of the land, and whose members

are bound by an oath of secrecy not to reveal the rules or proceedings of the body. Whether the German associations of to-day are secret in this sense of the term, it is obviously impossible to say definitely. In general, it may be said that a society is not secret if its proceedings, although not actually open to the public, are in effect public property, and if no mystery is made about them. Other associations which conceal their rules, membership and proceedings from the ordinary public, and which aim at accomplishing some result unknown to or in opposition to, the law of the land, may be called secret societies.

In the year 1919 there were in Germany a considerable number of societies which existed for the object of physical drill. Others had a still more obviously military complexion. Others again were purely political. Although much has been said and written about these, perhaps the first public evidence that has emerged in any considerable amount about them, is in the reports of the Munich political trial, associated with the names of General Ludendorff, Herr Hitler and Herr von Kahr. This trial arose out of the attempted revolution or *coup d'etat,* called the Hitler-Ludendorff *Putsch,* which occurred in November 8 and 9, 1923. The attempted coup was unsuccessful, largely owing to the action of the Bavarian "Dictator," Herr von Kahr, who was supposed at first to be favourable to the Putsch. The judicial inquiry or trial following upon the failure of the *Putsch* took place at Munich from February 28 to April 1. The result of the trial was the acquittal of General Ludendorff, the sentence of five years imprisonment in a fortress on Herr Hitler, and the complete exoneration of Herr von Kahr.

Extra-Social Organisations.

In the course of the trial, evidence emerged to show that the societies concerned in or sympathetic with the actions of Herr Hitler and General Ludendorff had certain general aims in common. These common aims appear to be as follows. Firstly, these societies are, naturally, nationalist: they are anxious to revive or maintain national, German sentiment. Secondly, they are anti-Communist, or anti-Marxian, as this aim was called in the Munich evidence. Thirdly, they are anti-Semitic, aiming at "freeing" Germany from so-called "Jewish capitalism." Fourthly, (this is more doubtful) the societies, or some of them, are perhaps monarchist, aiming at the substitution of a crown in place of the presidency.

Some of the associations are said to be organised and inspired by the celebrated Captain Ehrhardt. The names of these associations are given in an interesting report in the *Times* Newspaper for March 18, as the *Vikingbund,* the *Blucherbund,* the *Reichsflagge* (more probably the *Reichskriegflagge* or Empire's War-flag), and the *Chiemgau.* These are apparently military associations, so organised that the members, who are grouped in the towns and cities, can be "mobilised."

The Waffen bund.

It is said that there are numerous quasi-military associations, which retain, in civil life, the names, registers and mobilisation instructions of the regiments of the German army of the War-period. There is also believed to be a *German Fighting League.*

Many of the societies have probably a political and economic aim, namely, to preserve society on the basis of Western civilisation; they stand for individualism and private property. Such societies arose out of the circumstances of the Communist or "Spartacist" risings of 1919, and they are therefore similar, both in aims and organisation, to the Italian Fascist associations.

Whether the movement for extra-legal propagandist associations is as widespread in Germany now, as in the time of the *Tugendbund,* there is not sufficient evidence to make a definite statement. There is a "Young Germany movement," which has grouped together a number of similar associations in a *Jungdeutsche Ordnungs Bloc,* mentioned in the *Times* on March 16, 1924. Before the War Germany was full of propagandist societies of all sorts—Navy League, Agrarian League and others. The complex and infinitely ramified Trust or *Castel* movement was another aspect of the German aptitude and liking for extra-legal organisations.

Extremes meet.

It must not be thought that all the associations are nationalist and "bourgeois." The Communists or "Spartacists" have or had their organisations, some of which appear to have been distinctly "Bolshevik" in tendency. The "nationalist" societies may, from one point of view, be regarded as a legitimate means of self-defence against a social and economic danger which the German Government of 1919 appeared almost too weak to cope with. In point of fact, however, the German Republican Government showed a remarkable reserve of strength during the period of Spartacist risings, and it would be stronger still if it were openly supported by the nationalists through the ballot-box and other constitutional means. The existence of extra-legal associations, aiming at doing the police-work of the State, only makes the task of the Government more

difficult. The present German Constitution and Government are based on the principles of individualism and private property and the sanctity of contracts, so that its aim is, in this respect, the same as that of the nationalist societies. Moreover, the Government and the Constitution (from the circumstances of its origin in 1919) stand for the maintenance of the Treaty of Versailles, but some of the nationalist societies (according to Captain Ehrhardt's statement, given in the *Times* of March 6), aim, among other things, at the suppression of the Treaty of Versailles. Clearly the cause of European stability, political, social, economic, has more to gain from support given by European opinion to the legitimate Government, rather than to the extra-legal societies of Germany.

The formation and existence of extra-legal or secret societies with political aims is a characteristic of all States in which the central authority has become weak. It was so in the decline of the Roman Empire, it is so in Germany and in China to-day. The existence of, as it were, "States within the state," is only possible either where there is no common strong public opinion, or where the Government of the day is out of touch with that public opinion. These "states within the State" must not be confused with the legitimate party organisations, such as the German People's Party, the Social Democratic Party and others, which, whatever their aims, are purely constitutional in their methods. Political parties, of whatever complexion, whose methods are open and constitutional, are simply unofficial organs of the State and people, normal expressions of the public opinion through which alone civilisation, law and the social order exist.

Few books on Secret Societies are available. See Heckethorn's "Secret Societies," 2 vols.; Pollard's "Secret Societies of Ireland"; Gümbel's "vier Jahrs Politisches Mörd."

Colloids, as Seen Under the Ultra Microscope

By D. C. Henry, M.A.

The chemical and physical properties of colloids are engaging the attention of some of our ablest research workers. The subject is of vital interest to biologists, for it may throw light on some of the obscure processes of living cells, and has, in addition, a wide range of application in connection with applied science.

It must have occurred to many students of elementary chemistry that the substances with which they are mainly concerned in their practical work behave in a manner very different from the materials of which the most important part, the living part, of the world is built. The common laboratory chemicals are as a rule comparatively simple substances which can be obtained pure, and usually in crystalline form; they show reproducible properties—for example, a definite solubility in water and a well-defined melting point—and when they react with one another, they do so with reasonable celerity and in accordance with more or less simple chemical equations. It is quite otherwise with the substances which form, or have at one time formed, part of a living organism. These are frequently immensely complex bodies, difficult to free from impurities, and having properties which vary from time to time and from specimen to specimen. Gelatine, for instance, dissolves in warm water to form a viscid liquid which sets to a jelly on cooling; but the temperature at which it does so depends not only on the specimen of gelatine used, but also on the physical treatment which it has undergone. It will not crystallise from its solution, as salt or sugar do. The protoplasm, which is the chief constituent of the living cell, is a system of materials which are in a perpetual state of chemical reaction, but the reactions are not clear-cut, like those of elementary chemistry, and frequently take place with extreme slowness.

Organic Problems.

One might at first be tempted to suppose that the only difference between the materials of the chemistry class and of nature's laboratory is one of chemical complexity; the natural products have admittedly a much more complicated chemical constitution, and this fact might be supposed adequate to account for their more complicated behaviour. This is no doubt partly true, but it is not the whole truth. Much of the characteristic behaviour of organic material is due to certain peculiarities in its physical state, which are summed up (but not explained!) by saying that such substances are "colloids."

The name colloid was invented in 1861 by Thomas Graham, an eminent scientist who was also Master of the Mint, to describe a class of substances which showed just these peculiarities which are characteristic of living matter. He spent much of his time experimenting on the rate of diffusion of substances form

a place where their concentration is high to a place where it is low. He investigated, for example, the rate at which gases will pass under various pressures through a fine hole, and the rate at which copper sulphate diffuses into a layer of pure water carefully poured on top of a solution of the salt in a tall jar. In the course of these experiments he found a number of substances which diffused into pure water with such extreme slowness as to distinguish them sharply from ordinary soluble materials such as salts or sugar. These slowly diffusing substances all showed the further peculiarity that they were unable to diffuse through a membrane of bladder or parchment paper, whereas salt and sugar pass through it readily. As gelatine appeared to be a typical example of the non-diffusible substances, Graham named them "colloids" from the Greek word for glue, while the substances which showed normal diffusion he called "crystalloids," since he believed they were all substances which could be obtained in crystalline form. Graham's further experiments on various colloids, notably on colloidal silica, only served to emphasise their peculiarities; not only were they distinguished by lack of diffusive power, but they showed no well defined solubility, no characteristic chemical reactions, and no reproducible physical properties. They appeared to him to form "a different world of matter." He himself foreshadowed what is now believed to be the essential feature of all such substances—that they consist of matter in a very finely divided, or "disperse" state, such that their relative surface area is enormous.

Tension of Particles.

A simple calculation shows that matter in a finely divided state may develop an area of surface out of all proportion to that possessed by the same bulk in the massive state. A sphere of gold one millimetre in diameter has a surface area of roughly three square millimetres; if the same quantity of gold is subdivided into a thousand billion tiny spheres each one hundred thousandth of a millimetre in diameter, the surface area will be about a third of a square metre. Such a subdivision was actually achieved, by chemical means, by Michael Faraday, the blacksmith's son who became Professor at the Royal Institution; he prepared a colloidal solution of gold, containing particles about this size, which appeared as a clear ruby liquid, similar in colour to photographic ruby glass, a substance which is itself of similar constitution, being actually a solid colloidal solution of gold in glass.

Now why is it that the possession of such a large surface confers characteristic properties on a system? In ordinary experience powdered rock shows much the same properties as large lumps. True, but this is because we have not powdered it finely enough. French chalk is a fine powder, but its separate grains average a few hundredths of a millimetre across, an enormous size compared with the colloidal particles we are considering. The relative surface of the latter is some thousand times greater than that of the French chalk. Now there are many things which show that surfaces are possessed of energy simply because they are surfaces, and independently of any energy the material may possess in bulk.

Vast Surface Area.

One of the most familiar manifestations of this energy is surface tension, the force which tends to make liquid drops assume a spherical shape. A drop of mercury on a horizontal plate has a flattened shape, because gravity is pulling it downwards, but it will not flatten out indefinitely because its surface tension is continually drawing it together. The pull which is exerted by a soap film is another example of surface tension; it does not seem a very powerful force, but nevertheless the tension which a soap film can sustain work out at something over 20 kilograms weight per square centimetre of cross section—that is to say that a battery of soap films of aggregate cross section one square centimetre would support a bicycle!

With matter in bulk surface energy does not exert any considerable influence, for it forms only a small fraction of the total energy contained in the system, but when, as in colloidal solutions, the surface is greatly multiplied, surface energy becomes of paramount importance, and in fact determines the whole behaviour of the system.

Since the sole requisite for the development of colloidal properties is the possession of large extent of surface, it would be expected that colloids are not necessarily a class apart, as Graham supposed, but that any substance would show the properties of a colloid if sufficiently finely divided. This is found to be so, and it is possible to form colloidal solutions of such typical "crystalloids" as gold, sulphur and common salt. All that is necessary is that they shall be "dispersed" by suitable means in an appropriate liquid.

If a powerful beam of light is passed through a solution which is not colloidal, and which is truly free from dust and air-bubbles (not an easy thing to ensure), the path of the beam is not visible from the side. But if such a beam is passed through a colloidal solution, the path of the beam is visible laterally as an illuminated streak, usually of bluish

colour. This is because the minute particles in the colloidal solution scatter a certain amount of the light which falls upon them, some of which enters the eye of the observer looking sideways at the beam. This is a very sensitive test for the presence of suspended particles; one drop of milk in half a pint of water shows the effect strongly. The illuminated beam is called the "Tyndall cone," after the famous physicist of that name, although Faraday had previously observed and investigated the phenomenon with his colloidal solutions of gold.

The Ultra Microscope.

The principle of the scattering of light by small particles is employed in the ultramicroscope, a wonderful instrument which actually makes visible the individual particles of many colloidal solutions. In the common microscope, as ordinarily used, the object is examined by transmitted light, and if it is very small, the image is blotted out by the diffraction, or spreading, of the light from the background. In the ultramicroscope, the object is illuminated from the side, so that none of the incident light enters the objective directly, and the background appears dark. Each particle present scatters a little light, which thus enters the objective and forms an image as a disc of light which is easily visible on the dark ground. The appearance under the ultramicroscope of a drop of a colloidal solution of gold is extremely beautiful; the particles of different sizes give rise to discs of light of varying brightness and colour which scintillate like stars on a clear night. As will be explained below, many of the particles are in rapid irregular motion which continues unceasingly.

The limitations of a microscope are not due to imperfections in the optical construction; it is inherent in the properties of light that the image of a point will be, not a point, but a disc of finite size. The images of two points very close together will overlap and cannot be distinguished, and though there is theoretically no limit to the power of magnification there is thus a very definite limit to the power of "resolution," that is of separating closely adjacent points. As the particles of most colloidal solutions are far smaller than this limit, the ultramicroscope does not give an image which corresponds to the shape of a particle, but represents any particle, of whatever shape, as a circular disc of light. We cannot therefore examine the individual forms of the particles, but, what is nearly as valuable, we can count them and study their motions.

Since many colloidal solutions contain particles of a substance much denser than the water in which they are suspended, the question naturally arises—What keeps the particles from settling; or in other words, to what is the stability of such a solution due? The clue to this problem is to be found in the observations made by the botanist Robert Brown in the early part of the last century. In the course of his

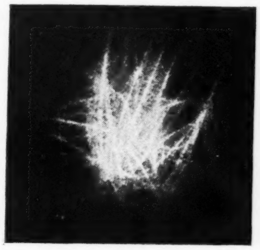


FIG. 1.

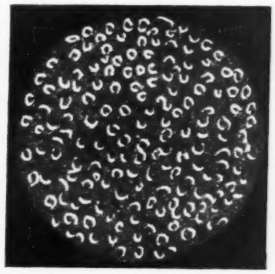


FIG. 2A.

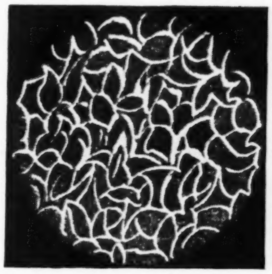


FIG. 2B.

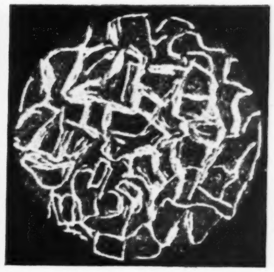


FIG. 2C.

FIG. 2D.

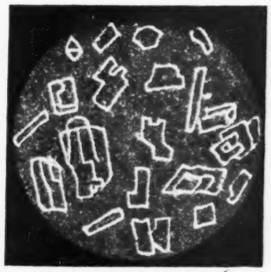


FIG. 2E.

ULTRA-MICRO PHOTOGRAPHS, SHOWING THE STRUCTURE OF SOAP JELLIES.

microscopic studies he observed that solid particles suspended in water, if of sufficiently small size, are in a state of perpetual agitation, moving hither and thither in an irregular zig-zag path.

Brownian Movement.

Though his observations were first made with grains of pollen, he soon proved that life had nothing to do with this motion, for he was able

to observe it with finely divided coal, sand and other inanimate objects. Successive workers have proved that the "Brownian movement," as the phenomenon is called, is not due to any extraneous cause such as vibration, heating effects and so forth, and it is now certain that it is caused by the bombardment of the particles by the invisible molecules of the liquid. It has long been known that these molecules must, at any temperature above the absolute zero, be in perpetual motion, and it is even possible to calculate what is the average kinetic energy of such a molecule. The molecules bombard any body immersed in the liquid, but in the case of comparatively large bodies, the bombardments are so numerous that the impacts on each side will on the average be equal, and no motion of the body is produced. With particles which are not very much larger than the molecules themselves, the impacts on each side at any moment will not always balance out ; there will be an excess of pressure now on one side, now on another, with the result that the particle is driven about in the irregular path which we observe. Mathematicians have calculated what the average velocity of the Brownian movement should be, on this theory, for particles of given sizes, and their predictions have been amply fulfilled by experiment. We have in the Brownian movement not merely an ocular demonstration of the motion of the molecules, but also an explanation of the stability of the suspended particles in colloidal solutions. For just as it is the incessant motion of the gaseous molecules of the atmosphere which prevents it from subsiding to the earth under gravity, so the Brownian movement of the colloidal particles keeps them from settling out of solution.

In the course of their motion, the colloidal particles are perpetually getting in each other's way, undergoing a sort of collision. If such collisions are watched under the ultramicroscope, it becomes evident that the colliding particles do not actually hit one another, but appear to rebound without direct contact. It is as if each particle were surrounded by an invisible cushion which prevents them from touching one another. This cushion is essential for the stability of the solution. By adding a suitable quantity of any salt to a colloidal solution, it is possible to eliminate this protective cushion, so that the particles actually come in contact when they collide. It is found that when they do so, they do not rebound at all, but coalesce, forming a particle of larger size.

Effect of Salt.

The process repeats itself many thousands of times a second, till all the small particles have coalesced to give bigger ones, and these again to give still bigger ones, till eventually the size is such that the Brownian movement ceases, and the particles settle to the bottom of the vessel as a fine powder. This process, which is frequently brought about by quite minute additions of a salt, is called "coagulation," and is a most characteristic property of one type of colloidal solution.

It may appear surprising that particles of a rigid substance, such as gold, will coalesce on mere impact ; two sovereigns do not adhere when pressed together ! But experiment shows that this is because the sovereigns are not absolutely clean ; they too have a protective cushion (of grease, moisture, or even a layer of air) which prevents them from getting into real contact with one another. Absolutely clean flat surfaces do, as a matter of fact, cohere when pressed together, as can be seen by pressing two freshly split surfaces of mica between the finger and thumb. Copper blocks have been polished so that one cube will support a chain of eleven others which are merely pressed into contact with one another.

The nature of the cushion which protects the particles of a stable colloidal solution from coalescing is still a matter of some doubt. It is pretty clear that electricity has something to do with it, for it is easy to show that all the particles of a stable solution carry electric charges, while the same addition of a salt as causes the colloid to coagulate is also found to reduce the electric charge on the particles to zero. It is almost certain that it is the electrolytic "ions" of the salt which effect both processes. As is well known, when a substance such as common salt, sodium chloride, is dissolved in water, it splits up into sodium ions, which are positively charged atoms of sodium, and chlorine ions, which are negatively charged atoms of chlorine. The ion which has the opposite charge to the colloidal particle is attracted on to the surface of the latter, and neutralises its charge. The neutralisation of the charge removes the protective cushion, and the particles can coalesce. Exactly how it is that the electric charge on the surface of the particle acts as a protective cushion is not understood.

Emulsoids and Suspensoids.

We have hitherto been speaking largely of one type of colloidal solution, known as "suspensoids," in which the colloidal particles are solid. There is another type in which they are themselves liquid ; these are called "emulsoids," and are of special importance in the physiological applications of colloid chemistry, since most of the colloidal materials of living matter are of this type. Gelatine, egg-white and soap are typical examples of this kind of colloid.

Many emulsoids show very distinct differences of behaviour from suspensoids. They are not nearly so sensitive to the addition of salts. Thus, while a typical gold solution is completely coagulated, so as to precipitate the gold as a blue powder, by one tenth per cent. of sodium chloride, it requires twenty per cent. of the same salt to produce any visible coagulation in a solution of egg-white. Again, emulsoids are as a rule much more difficult to examine under the ultramicroscope; the emulsoid particles are similar in optical properties to the liquid in which they are immersed, and consequently scatter very little light.

These and other facts lead to the conclusion that an emulsoid solution differs from a suspensoid, chiefly in the circumstance that, in the former, both the colloidal particle and the liquid in which it is suspended contain both constituents of the solution. Thus a colloidal aqueous solution of gelatine consists of semi-solid particles of gelatine containing some water suspended in a liquid which is a dilute true solution of gelatine in water. These particles have electric charges, but their presence is of less importance than with suspensoids. The chief role in determining stability and the effect of added salts is played by the surface tension between the particle and the surrounding liquid, and by the relative proportions of gelatine and water contained in these two. The more alike are the particles and the liquid, the less will be the surface tension between them, and the less will be the tendency for the particles to coalesce.

Buffer Substances.

Emulsoid colloids of one particular and very important class, the proteins which form the material of the living cell, are very sensitive to the acidity or alkalinity of the liquid. This is because the protein colloid particle is actually a giant molecule which has the properties both of an acid and a base; which of these functions predominates depends on the acidity or alkalinity of the solution. In solutions of certain degrees of alkalinity the proteins tend to coagulate. The body fluids contain so-called "buffer" substances whose function is to keep the acidity of the cells constant at a suitable value for the operations of the cells, and proteins themselves appear to act in this way. In the process of exercise, acid is produced, and it is likely that some of the effects of fatigue are attributable to the effect of this on the colloids of the body.

Most emulsoid colloids have the power of setting to a jelly, a phenomenon which is familiar in the case of gelatine and of soap. It was at one time thought that jellification was caused by the joining together of the semi-solid colloidal particles to form a honeycomb structure, the cells of which contained the more fluid medium. This theory accounts well for many of the properties of jellies. It is, for example, possible to squeeze liquid out of a gelatine jelly, but only under very considerable pressures; this is naturally accounted for in the honeycomb theory, since the fluid is supposed to be totally enclosed in the cells of the structure, and would have to pass through the more solid walls in order to exude.

Skeleton Jellies.

Recent evidence however tends to show that jellies owe their rigidity, not to a continuous cellular network of the more solid constituent, but to the formation of a mat of interlacing needle-shaped structures of the latter, which form a skeleton, the interstices of which are filled with fluid. Figure 1 shows an ultramicroscopic photograph, taken by Professor Zsigmondy, showing this structure in the jelly of a sodium oleate soap, while Figures 2, *a* to *e*, show the changes of structure which were observed to take place in a potassium stearate soap in the process of setting; starting from separate colloidal particles (*a*), we pass through various stages of needle-shaped network (*b*, *c* and *d*), to the formation of definite crystals of potassium stearate (*e*).

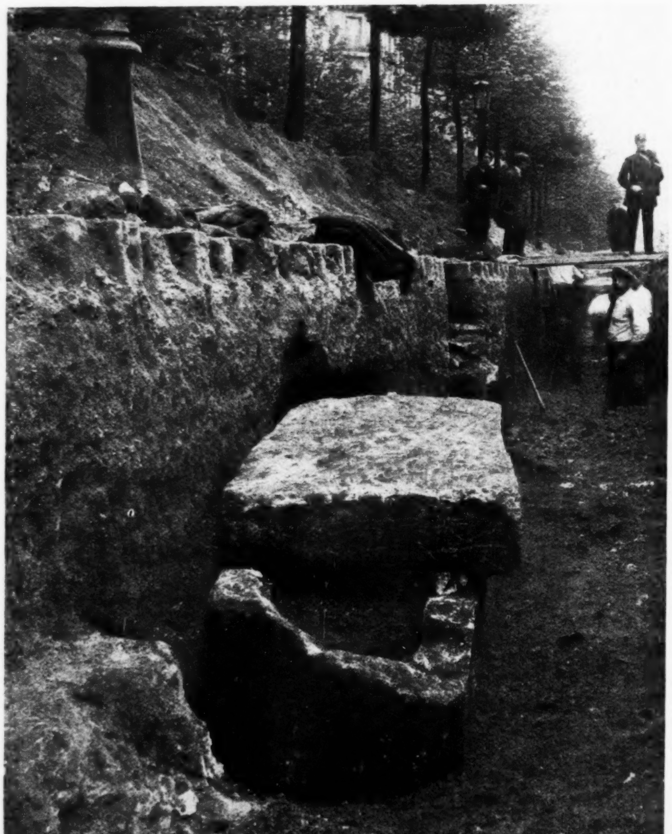
In *Man* for April, Capt. M. W. Hilton-Simpson describes a pole lathe in use in the Aurès Mountains of Algeria in which the motive power is derived from the free end of a pole which is fastened vertically to the floor near the lathe, by means of a rope passing around the chuck to a treadle. He compares it to an exactly similar lathe, still in use for turning chair legs at Stokenchurch, Bucks., the only differences being that in the latter case the pole is horizontal, one end being fastened to beams below the roof of the workshop, and that no chuck is used, the power being applied directly to the chair leg. The interest of Capt. Hilton-Simpson's account of these lathes does not merely lie in the survival of a very primitive type in Buckinghamshire. There is evidence which points to the possibility that in Algeria, the lathe, like so many other elements in the domestic culture of the Aurès Mountains, may be of Roman origin and if this be so, it is probable that it is also of Roman origin in this country. Capt. Hilton-Simpson has already suggested that the flour mills driven by a horizontal water-wheel common in Algeria and in this country, also probably have a common Roman origin. He was not aware at the time of writing that the pole lathe also occurs in Berkshire, where it is employed in the making of wooden bowls, and it is interesting to note that these bowls have a form of considerable antiquity, probably going back to Saxon times, as is suggested by some of the examples found in the recent excavations of a Saxon cemetery at Bidford-on-Avon.

Pagan Paris Two Thousand Years Ago.

Recent discoveries throw light on earliest inhabitants. The city was even then full of foreigners.

THE LATEST DISCOVERIES OF GALLO-ROMAN TOMBS.
By Robert Wilton.

RECENT discoveries of Gallo-Roman tombs in the St. Marcel quarter of Paris bring us back to the days when this was a mere hamlet on the outskirts of Lutetia, the Roman city that occupied the present site of the Latin Quarter, associated since the Middle Ages with the University of Paris. Hundreds of graves have been found near the famous Gobelins tapestry manufactory at the corner of the Avenue des Gobelins and the Boulevard St. Martel where stood an early Christian church. Recent finds include pagan as well as Christian tombs.



Hitherto pagan burials were almost exclusively associated with an ancient cemetery on the site of the Rue Nicole, and with the tiny Cimetière de St. Vincent, near the present church of St. Germain-des-Près, where stood a temple of Isis in Roman days. From the legend of this building it has been held that the name of Paris was derived from the Egyptian goddess, and till a century ago the arms of the city contained a figurehead of Isis adorning the prow of the emblematic ship. Latest theories incline to the belief that the name was really connected with a certain Iccius, a Gaul who owned the land on which the temple, and later the abbey church, were built. But it is certain that the Celtic tribe which held the surrounding country was known by the name of Parisii long before the city lost its Latin name of Lutetia.

Strangers' Bones.

Confirming and extending our knowledge of Paris in the early centuries of the present era, the sepultures brought to light in the course of laying new gas-mains along the Boulevard St. Marcel have roused anthropologists to a discussion of the racial characteristics of the population of Paris two thousand years ago. Some of the skeletons are of great size; others suggest kinship with the aboriginal inhabitants of France; others are of the Gallo-Roman blend of Celtic and other races. All goes to confirm the view that the Lutetian population, which probably did not number more than 20,000-30,000, was as much of a mixture as the 3,000,000 peopling Paris to-day.

According to the minutes of the Commission du Vieux Paris, recording the recent discoveries, it appears that the tombs were found near the site of the first finds, noted by Vacquer, in 1875-1880, when some of the houses in the Boulevard St. Marcel were under

construction. Twenty-five tombs have been unearthed during the present excavations, bringing the total hitherto dug up in this cemetery to over five hundred.

Some of the sarcophagi were roughly pieced together with small blocks of stone, just like early Gallic tombs, the corpse being compactly covered with earth and a stone slab placed over all; other sepultures were provided by a huge trough hollowed out of a single block of stone six feet long, eighteen inches wide and twenty-four inches deep and covered with a nicely adjusted stone lid. As in the case of previously discovered tombs, some of the stone used for the sarcophagi showed traces of having served for building purposes, presumably taken from the ruins of the first Roman city, destroyed by Germanic hordes at the close of the second century A.D.

The remains recently found had been interred without any funereal accompaniments; apparently they were even bereft of clothing. No vestige of metallic ornament, worn on the person or used on garments, has been detected in the sarcophagi, nor any trace of pottery or glassware; though experts declare that the tombs have not been violated nor the remains disturbed. The skeletons are well preserved, and some of the finest sarcophagi have been placed in the Carnavalet Museum, which shares with the Hotel Cluny the honour of harbouring relics of the city's past.

Two of the finds were particularly interesting, the bodies having been buried without any coffin, which is often significant. The skeletons were lying with a stone for pillow—a custom closely resembling the ancient mound burials of the coast of Brittany. These sepultures probably are not more recent than the first century A.D. Some fragments of rough pottery, bowls or flasks, were found associated with these earlier sepultures.

Typical Burials.

Detailed study of the human remains under review is proceeding at the Paris anthropological laboratory under the direction of M. Clavelin, but from a cursory inspection by Dr. Capitan, the noted anthropologist, who, with M. Grimault, of the city archæological survey, supervised the excavations, it may be asserted that the relics denote the presence of: (1) a fine but mixed race, made up of divers elements, corresponding with the known constituents of the Gallo-Roman population then living in Paris; (2) several individuals of large stature and strongly knit frames, representing, it is thought, the barbarian German invaders; (3) lastly, two or three specimens displaying, in the skull and limb bones, characteristics peculiar to the Cro Magnon type (successors of the Mousterian or Neanderthal men), which peopled various parts of France as far back as 12,000-15,000 years ago.

It is thus suggested that survivals of the aboriginal race of France were not infrequent in Gallo-Roman times. They are to be met with among the present inhabitants of France. A projecting chin, long but not narrow skull and large eye-sockets denote such reversion to aboriginal type. The numerous remains left in the Seine and Marne valleys by the Senoni, an important Celtic tribe to whom the Parisii were tributary, reveal a considerable proportion of Cro Magnon types, showing how important was this element in the production of the Gallic and French nations and of their mental as well as physical peculiarities.

The site of old Lutetia, which includes the fashionable St. Germain quarter, as well as the low-lying quarter on the left bank of the Seine, has been fairly well explored during the past half century and found to be pitted with Roman sepultures. Some crematoria were traced as far away as the Rue du Hameau, near the Versailles gate of the city. Tombs, isolated or in groups, have been found on the very outskirts of old Lutetia, in the Rues de L'Odéon, de Seine and de Vaugirard. The principal burial ground, however, was in and around the present Rue Nicole.

Popular legend and superstition recalled this fact long after precise knowledge on the subject had vanished, Paris of the Middle Ages knowing nothing of its Roman past. Thus the site of the old cemetery bore such gruesome appellations as Locus Cinereus, Clos de Mureaux and Fief des Morts, and the royal Château de Vauvert which stood there had, according to the Carthusian monks of the neighbourhood, such a population of ghosts that the king was constrained to make them a present of it.

Haunted Ground.

When the old monastery grounds, extending along the present Boulevards Montparnasse and Port Royal, were parcelled out in the XVIIth century and buildings began to go up, outlying sepultures of the Nicole cemetery were discovered. Sauval, one of the earliest students of Parisian antiquities, had already noted the presence of old tombs in the monastery gardens. In 1873, when the Nicole market was being built, Vacquer located fifty more sepultures; in 1878 a hundred and fifty tombs were revealed, many with headstones and inscriptions. Later, in 1903, a handsome gravestone was found in the Rue Cassini depicting a blacksmith at work. Most of these remains had been buried in the bare ground and some in wooden

coffins; only a few in sarcophagi. There were also traces of cremation.

None of the sepultures denoted the eastward position. There were traces of pottery. Coins had been placed in the mouth, in one hand and in one eye of the corpses, denoting a Roman rather than a Gallic ceremonial. The coins were mostly of the 2nd and 3rd centuries A.D., ranging from Vespasian to Domitian, besides medals bearing effigies of the Emperors Trajan, Hadrian, Antoninus Pius and Marcus Aurelius. The Nicole cemetery had evidently been in use since the later half of the 1st century, when cremation was still practised, but was chiefly used during the 2nd and 3rd centuries. Only two hundred and fifty burials have been traced—a very small proportion of the dead that must have been interred there.

Cremation.

The Gallo-Roman city was then at the height of its splendour. Its forum, its spacious, well-laid thoroughfares; the great public baths (under the Cluny Museum), its stately theatre and public halls (on the sites of the Lycée St. Louis and the Collége de France), the Temple of Jupiter (where now stands the Pantheon), and the arenas or circus, remains of which may be seen in the Rue Monge, were the principal landmarks of the Latin agglomeration on the left bank. Remains of the old Roman city abound in the Rues Le Goff, Gay Lussac and Soufflot. But the bulk of the people preferred the huddled cluster of older dwellings in the Cité near the little bridge connecting the islands with the Roman town.

Still, there is little doubt that Lutetia was by no means so important as one might infer from a mere recital of its edifices. The theatre was small and the circus could not accommodate more than nine thousand spectators, although it was intended to be the chief centre of attraction for all the surrounding population. Lastly, the Roman aqueduct was calculated to provide for about five thousand inhabitants. All this may account for the fact that Lutetia is so seldom mentioned by Latin historians, although several Roman emperors, including Julian, visited and even lived in the city.

Judging by the inscriptions found on Gallo-Roman tombs, the inhabitants of Lutetia spoke very crude Latin, like the rest of the Gauls, who forgot their native Celtic tongue during the early centuries A.D. But many still cherished the memory of their independence and declined to Latinise their names. This steadfastness is disclosed by the names of Gallic seatholders in the circus. Some of the inscribed stone tiers of the amphitheatre may be seen in the Cluny Museum, where also the celebrated sculpture of the *Nautes* gives excellent life-like portraits of some early Parisians.

German Invasion.

Following the invasions of barbarians who ravaged Gaul, and destroyed Lutetia at the dawn of the 3rd century, the inhabitants were more than ever inclined to cling to their island homes. But military exigencies compelled the Romans to rebuild their wonderful edifices and incidentally to complete the Latinising

of the Gauls. As a result of the first invasion of Lutetia by German hordes the city became more completely Latin in character.

This probably accounts for the origin of the St. Marcel cemetery. Persecution of the early Christians edicted by the Roman emperors led followers of the despised Nazarene to shun dangerous publicity in Lutetia; they betook themselves to a little hamlet, some two miles south of the Cité, the abode of humble stone-quarriers, and it is likely that the quarries along the steep banks of the Biévre, a stream that has been obliterated by the advance of Paris, offered shelter, like the catacombs of Rome, to Christians who escaped the horrors of the adjacent circus during the fury of imperial persecutions.

The distinctive feature of the St. Marcel cemetery is that all the bodies were interred with the feet and eyes towards the east. Burial took place here as late as the 17th century. Most of the five hundred tombs found in past years had been plundered. There is a legend that St. Marcel, the evangelist of Paris, was himself buried here in 436. The chronological sequence of the sepultures is very clearly marked, beginning with uncoffined burial, followed by interment in a wooden coffin, as shewn by nails fallen around the body, rectangular sarcophagi of rough stone, then stone troughs and plaster tombs adorned with circles, crosses and chrisms (Merovingian epoch), lastly the Carlolingian tombs of white stone, after which come stone-lined vaults. In some places four superimposed tiers of sepultures have been excavated.

Roughly speaking, the St. Marcel burial ground lies within the following limits: S., the Gobelins tapestry manufactory; N., the Rue du Petit Moine; E., the old Horse Market; W., the Rue Pascal. It was densest near the old church which stood where the Boulevard St. Marcel debouches from the Avenue des Gobelins. There was a children's cemetery at the corner of the Boulevard Port Royal and the Boulevard Arago. Explorations are still being made.

Fairy Origins.

By Lewis Spence.

It is surprising, in view of all that has been written with regard to the origin of the Fairy Folk, that attention has not so far been directed to the etymology of the word "fairy" itself, as supplying a clue of indubitable accuracy both to the nature and descent of the "good people." For the name "fairy" is now, and has been for generations, wrongly applied. It is derived from the Middle English faerie or fayrye, a word meaning "enchantment," and this again comes from the Low Latin fata, a corruption of the classical fatum, "fate." The correct term for a "fairy" or elf is "fay." "Fairy" or "faerie" is the place of fays, the atmosphere in which they exist, the fay-realm, fairyland; so that when we speak of one of the elfin race as "a fairy," we are as much at fault as if we were to use "Britain" instead of "Briton" to denote an inhabitant of these islands.

The Roman soldiers who garrisoned Gaul spoke of their own Italian goblins as fatae. In Upper Brittany the fay is still called a fate. The Gauls corrupted fatae into fay, slurring the "t" and laying stress on the initial "a," and applied the word to their own native spirits of wood and wold, the teeming lesser pantheon of the Celtiberian imagination. A fay or fairy was to them not necessarily a tiny sprite with gauzy wings, dressed like a gift-doll from a Christmas tree. The whole supernatural population of their mythology was gradually included in the term fay, and to this were later added the sprites and demons of invading races. A cursory examination of the names of several of the most celebrated denizens of Faerie will readily persuade the doubter of the truth of this novel point of view. The etymology of the name Oberon, for example, is well known. It is merely a Gallic corruption of the Teutonic Alberich, "Elf-king." Titania, his spouse, is of loftier origin, none other than the great Diana herself.

The Lordly Ones.

Puck is merely the Old English word pooka, "a spirit," a word cognate with the Dutch spook, "a ghost." Morgan le Fay, the Fata Morgana, is but the Gallic-Irish Morrigan, "the Great Queen," who took the shape of a raven and hovered over the field of battle like the birds of Odin. Here, then, we have a Germanic elf, a Græco-Roman goddess, a Saxon hobgoblin, and a Celtic divinity of war all masquerading as fays. Artists depict them with the diaphanous shape and butterfly wings of the fay, yet, through their names, we can trace them to their provenance, and argue therefrom that they were supernatural beings of one class or another, exiles from the mythologies of several

different races, who, through a variety of reasons, succeeded in surviving in the popular imagination until at last they were swept along with many other similar forms into that great limbo of godlike, goblin, and ghostly figures, that detritus of vanished religions and popular superstitions, which came to be known by the generic name of " fairy."

That in many countries fairies were regarded as connected in a sense with the dead there is proof pressed down and running over. They were thought of as dwelling in a dim, subterranean sphere, in sepulchral barrows, or in a far paradise, like those fays encountered by Ogier the Dane or Thomas the Rhymer. The Fairy Queen in the old ballad warns Thomas against eating the apples and pears which hung in her gardens, for to partake of the food of the dead is to know no return. This place of faery seems to be the same as the island of Avalon (the Place of Apples) or the Celtic Tir-nan-Og, the Land of Heart's Desire. A fairy who taught sorcery to the Scottish witches was said to have been killed at the battle of Pinkie some thirty years before, and Kirke in his " Republic of the Elves " makes it plain that he regarded them as the spirits of the dead. I fancy, too, that in the wearing of butterflies' wings by the fays of art and folk-tale one can discern a folk-memory of that Celtic belief that butterflies were the souls of the dead. Some races still cherish the belief that on the death of a person his soul at once takes up its abode in the body of a newly-born child. But the fairies are souls waiting their turn in a dim paradise for an opportunity to recommence the earth-life.

Dwarfs and Elves.

The belief that the fays were a dwarfish race appears to have been borrowed from the idea of the small and swarming Teutonic elves. The fays of Celtic folklore are of normal human height. The Irish Sidhe, Morgan le Fay, (Urganda in her Spanish shape), the Welsh y Mamau, or " the Mothers," are all of mortal bulk. So were the Breton fays and those Scottish fairies who carried off Tamlane and taught witches the lore of the sorcerer. Nor does the theory that the former existence of conquered races of dwarfish stature, who sedulously avoided their conquerors, gave rise to the belief in fairies, much commend itself. These smaller peoples themselves possessed tales of fairies. Efforts have been made to show that the Picts of Scotland were of dwarfish stature, and that their final defeat by the Scots led to their dispersal and consequent habitation of earth-dwellings. Hence the belief in brownies and fairies ! Unhappily for this notion, the Picts were not conquered, but absorbed through a Royal marriage into the Scottish hegemony about 844 A.D. The name " Pict " fell into desuetude, was absorbed by that of " Scot," which came to designate the united peoples, and this later gave rise to a popular legend that the " little " Picts had withdrawn from association with the Scots. The Picts, as Professor Watson, of Edinburgh, has recently shown, were a seafaring people of Poitou, who settled in Scotland during the fourth century A.D. Those of Galloway, isolated from the remainder of their race, retained the name of Pict as late as the Battle of the Standard. That they were of dwarfish proportions is belied by everything we know concerning them.

If the foregoing arguments be well founded, it becomes clear that the name fay or fairy must have a much wider acceptance for us than formerly, that the beliefs concerning fairies can be paralleled by those still obtaining among primitive peoples, and that by virtue of these analogies, as well as by a consideration of the etymology of the name, we can probably arrive at a better understanding of the true character of the so-called " little people."

BIBLE WIZARD.

A dispatch from the Ottawa Correspondent of the *Daily Express* which appeared in the issue of April 11th, records a remarkable instance of the arctic hysteria to which reference was made in an article in DISCOVERY in April last. According to reports brought in by the Royal Canadian Mounted Police, the outbreak occurred in an Eskimo village within the Arctic Circle, but of which the precise situation is not stated. Shortly after the coming of winter an Eskimo, Neakutuk by name, who was company factor and an important member, probably headman, of the settlement, announced that the Great Spirit had ordered him to lead his fellow villagers to the Land beyond the Stars. He pored for hours over his Bible, and at his direction fasts and ceremonies, evidently from the account of a violent character, were performed by the whole village. The whole community apparently became subject to a form of melancholia and religious mania. Suicides and murders were frequent until the coming of spring when Neakutuk was killed by one of the tribesmen — described as the " village strong man" — because he had struck a woman who had broken one of his rules. The reason is probably incorrectly reported.

The whole account is one of extreme interest for the study of primitive religion. It illustrates the persistence of the influence of environment on temperament in relation to religious emotion, notwithstanding the influence of Christianity. As was shown in the note in DISCOVERY to which reference was made above, the rites and observances of the shamanistic religion of the tribes within the Arctic Circle of Eastern Asia and of the Eskimo depend to a considerable degree upon the highly strung and ill-balanced temperament of the people which is exhibited in an exaggerated form by the Shaman or " Medicine Man," who thereby maintains his position as the spiritual head of his village or group. The concentration of attention on the Bible to which reference is made suggests a mental state comparable to the ecstatic trance of the medicine-man which always precedes the Shamanistic rites.

Origin of Votes and Proceedings.

By C. S. S. Higham.

How the right of the people to know what was being done in Parliament through the columns of the press was finally established.

To-day there is issued every morning during the Parliamentary session, the Votes and Proceedings of yesterday's sitting of the House of Commons; they are practically the minutes of the previous day's business, and are now of little interest to any except those technically related to the House. It was far different when they were first printed in 1680, for the Votes and Proceedings were a direct appeal by the Commons to public opinion without the House, and when they first appeared they were wildly sought for by a public whose political sense was not yet jaded by the Leader or the Parliamentary correspondent of the modern newspaper.

The early view, which still holds good to some extent at least in theory, was that Parliamentary proceedings were private, and that to report them was a high breach of privilege, but despite this the growing political interest of the seventeenth century had to be met, and so reports of what was going on in the House were freely circulated, by scribblers who made innumerable copies by hand, by pirate sheets off-printed in haste, by members themselves, who, like Andrew Màrvell later in Charles II's reign, wrote regularly to their constituencies, or who gave copies of their speeches to the hack-writers of the day. Yet in the growing struggle between King and Parliament, the King had all the advantage of publicity, for it wascustomary for the King to make use of the printing-press, and circulate as pamphlets or flysheets the speeches and messages he sent to Parliament; a famous example of this type of propaganda is the Declaration made by Charles I in 1629 of the causes which led him to dissolve Parliament, in which he seeks to justify his position, and to pave the way for his attempt at autocratic government. The Commons were handicapped in this war of propaganda alike by their theory of secrecy, and by the fact that they could do nothing after the dissolution; hence it is a fundamental change of position when the House decides to make official use of the printing-press to appeal to public opinion; this step was first taken, as might have been expected, by the Long Parliament.

Need for Publicity.

It was in the midst of the excitement caused by the trial of Strafford and under the fear lest the King might try to save his servant's life by the use of force that the Commons, under Pyms' lead, decided on an appeal to the nation. Thus the Protestation was drawn up, containing an oath pledging the taker to protect the Protestant religion, the King and Parliament; this oath was taken by the Commons, the Protestant Lords and circulated in the city. A few weeks later the Commons determined to use this formula to exclude papists from office, and when the Lords threw out their Bill, the Commons decided on their sole authority to print their resolution, and that members were to "send down to the several places for which they serve copies of this Vote of the House concerning the Protestation." From this small beginning the Commons quickly developed the use of the printing-press as their quarrel with the King grew in intensity, and as they began to grasp èxecutive authority, resolutions, orders and explanations as well were published in increasing numbers, and the House thus strengthened its position against the King by an appeal to outside opinion.

The Speaker's Ruling

These publications, however, were only occasional papers, and though at times the Commons of the Long Parliament winked at the reporting of their proceedings, they did not publish an official and continuous record. In November 1641 they set up a committee to watch over unauthorised printing, and included among its instructions the direction "especially that they take care to suppress the printing and venting in MS. the diurnal occurrences of Parliaments." Yet printing proved a formidable weapon in the long struggle, and the House was often able to publish documents which damaged the King's cause; a famous case is the secret Glamorgan treaty of 1645 negotiated on the King's behalf with the Roman Catholic party, which fell into the hands of Parliament and was promptly printed. A few years later in 1649 when the Commons abolished the House of Lords, their reasons were printed for general information.

A change came over the scene after Cromwell's expulsion of the Rump, and even after 1660 the Cavalier Parliament was little likely to go out of its way to follow the initiative of the hated Long Parliament. Now and again a paper was printed, but

the tendency of the time and the new Press Act, which required all printed matter to be licensed by a censor, worked in another direction. An amusing debate arose in 1673, when some M.P.'s wished to print a Petition of Grievances concerning the abuses of billeting and martial law, together with the King's somewhat vague reply "that he would see to it that no man had cause to complain." It was argued that the Press Act prevented the Houses from ordering their petition to be printed, while to request the King to give such an order would look like doubting the sincerity of his promise to redress the grievance. On a motion for the adjournment there was a tie, and Mr. Speaker gave his casting vote for the adjournment with the jest "that he would have his reason for his judgement recorded, viz., because he was very hungry." So different was the spirit of the times from the great days of the Long Parliament.

But things were to change once more, and the panic of the Popish Plot was to bring into being a series of three short Parliaments, keenly opposed to the policy of the Crown and determined to base their power once more on public opinion. When in 1678 the famous letters of Coleman were discovered, the Commons entered three of the most damnatory on their Journals and asked the Lords to join with them in petitioning the King for their publication, but the Lords were dilatory and the Commons were soon absorbed in other matters. A little later, in January 1679, the Cavalier Parliament was at last dissolved, the Press Act lapsed, and the elections were held amidst a whirl of excitement which brought back a violent Whig majority pledged to search the "Plot" to its roots and to exclude James, Duke of York from the throne.

The Hidden Hand.

To save his brother's claims to succeed, Charles dissolved the Parliament, and another, after a year's prorogation, met at last in a thoroughly unmanageable mood. Pamphlets of every description were flooding the country, and the Commons desired to advertise their share in the hue and cry. The Whig majority determined to follow the example set by Pym in 1641, and appeal to public opinion by using the printing-press, but instead of printing a series of isolated resolutions or papers, they resolved, on November 30th, 1680, to print their Votes and Proceedings daily; these minutes were to be signed by the Speaker, and these gave an official summary of the business done by the House. In addition the Commons added to the mass of lies and misrepresentations which were in circulation by authorising first one and then another of the witnesses to the "Plot" to publish the evidence which they had given to the House.

The crisis came when this Parliament was dissolved, and its successor met a few weeks later at Oxford; the country stood on the brink of revolution, and the Commons at once discussed the question of printing their Votes. The debate is notable for the doctrines laid down. "Let men think what they please, the weight of England is the people, and the world will find, that they will sink Popery at last," declared Sir William Cowper, as he recorded the motion for printing. Only one voice was raised in protest, the Oxford don, Sir Leoline Jenkins, Secretary of State, put the government view: "Consider the gravity of this assembly, there is no other Assembly in Christendom that does it. It is against the gravity of your Assembly, it is a sort of appeal to the people." Quickly he was answered by member after member.

Commonsense Triumphs.

"The printing is like plain Englishmen who are not ashamed of what they do," declared one John Bull, "and the people you represent will have a true account of what you do." "But pray who sent us hither?" asked another. "The Privy Council is constituted by the King, but the House of Commons is by the choice of the people. I think it not natural or rational that the people who sent us hither should not be informed of our actions." And so it was agreed again to print the Votes; a few days later Parliament was suddenly dissolved, and a period of reaction set in, but a great principle had been firmly laid down. Though it was again to be discussed, the doctrine had been accepted that the House was strengthened by the support of public opinion, and that the electorate should know what the House was doing. The symbol of that alliance was the little flysheet, The Votes and Proceedings of the House of Commons.

* * * * *

Authorities. There is little easily available on this subject. The development of Parliamentary printing has to be traced by the different entries in the printed *Commons Journals.* Our knowledge of the debates for the second half of the 17th century rests chiefly on a collection made by Auchitell Grey, a contemporary M.P. These were used by Cobbett in compiling his *Parliamentary History,* and the quotations in the article are from the latter work. The printed pamphlets and royal declarations may sometimes be picked up in second-hand bookshops, but I have never been lucky enough to come across a copy of the *Votes and Proceedings.*

Coral Islands—PART II.

By Cyril Crossland, M.A., DSc., O.N., F.Z.S.

The author has now sailed on the Research Expedition of the yacht St. George and expects to investigate Coral formations in the Pacific Ocean. He will contribute articles on his progress in the field.

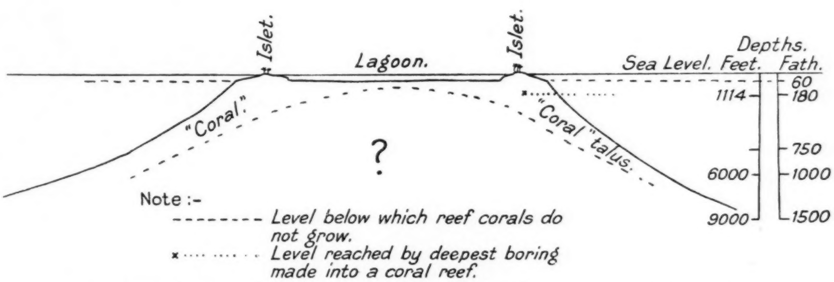
HAVING explored a reef fringing continental land on the seaward reef of an oceanic islet we turn to the lagoon enclosed within an atoll ring or a barrier.

The village from which we start is on the sheltered lagoon shore. Even in large lagoons—and some are big enough to be seas in themselves—the waves are never comparable to those of the ocean beating upon the outside of the barrier or ring and the lagoon is accessible to fishermen in all ordinary weather. Further, it is on this side of the islands that fertile soil is found, oceanwards the land is more completely formed of coral clinkers; here is home and shelter, there windswept desolation, the haunt of evil spirits. Home and desert both within an island a few hundred yards across, if so wide!

Consequently, the blue of the lagoon water is a comparatively light tint in contrast to the steely blue-black of the ocean outside. Shoals in the lagoon have beauty of colouring apart from that of the individual corals. The general colour of a coral bed is brown, that of the sand patches which make up most of the surface white, but both colours, seen at a little distance are modified, graduated by the depth of water, so that the sand appears of all tints from white, through green to blue, the whole reef being a gem of exquisite and brilliant colours.

Sapphire and Indigo.

A bed of living corals is a sight which can never be forgotten yet never worthily described. Museum collections can give an idea of the extraordinary variety of form which can result as modifications



Imaginary section through an atoll, shewing steep slope to great depths outside the reef and islets. Interior rock formation unknown.

of a single type of life, but nothing but the actual living reef can give the impression of abounding vigorous life to these trees and fungi, domes and cylinders of stone. The museum fails in another way to convey the impression of a living reef in that the corals are separated from the myriads of other creatures, both fixed and swimming, which complete the coral community. Corals have plenty of parasites and commensals, but in addition there is a whole fauna dependent on the corals for its necessary environment though neither parasitic nor commensal.

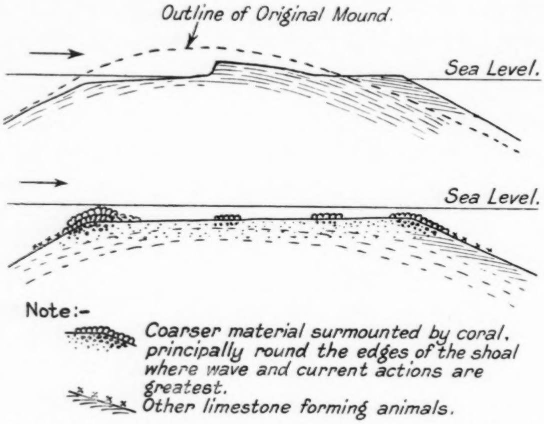
Corals do not very frequently grow in a level bed, and indeed that is neither the most characteristic nor most interesting way of seeing them. More often they form a precipitous bank, dim shapes rising out of blue depths becoming clear to every detail nearer

The sandy beach by the village may descend into a rock flat much like that below the cliffs of the other side, or may continue down into deep water or pass into an area of growing coral. The term deep water has a different significance in the lagoon, however. On the ocean side we mean by it hundreds or even thousands of fathoms, equal to the heights of mountains, but though the lagoon may be deeper than the North Sea, such depths are insignificant to those found quite a short distance outside the atoll ring. For instance, in the diagram of the slopes outside the ring it has been necessary to give the lagoon its maximum depth (40 fathoms=twice the depth of most of the North Sea) in order to make it visible, and the palm trees have been given a height of 300 feet to make them show at all.

the surface. So pure is the water that we have perfect vision for depths of say 30 feet, after which objects are seen through a beautiful blue haze deepening in tint, the corals becoming dark, the white sand green, scarlet sponges jet black, till all disappear in the blue at about 60 feet. In a locality where big "heads" of coral grow to near the surface, each head compounded of literally hundreds of species of animals, conditions are ideal.

Colour of the Corals.

In spite of the fact that the general colour of a bed of living coral is brown, there are plenty of more brilliant



Fate of a volcanic mound slightly raised above sea-level. Top, Section of Falcon Island at time of Lister's visit. Below, its subsequent reduction to a bank 30 fathoms below sea level with coral animals building on it.

tints. Most of the branches of the madrepores end in pink or green, or light violet, the actual terminal polyp being white. Other forms, in which, like the madrepores the stony skeleton is more evident than its clothing of fleshy polyps, show green or light red all over ; one, which grows in great horizontal sheets like elephants' ears is gamboge yellow. In another, but smaller number of species the polyps are always more conspicuous than is their stony support, *Galaxea* appears as a mass of tentacles, generally green, sometimes brown, quite hiding the stony calices and septa so prominent in the dry skeleton ; *Mussa* has great fleshy polyps an inch or two across in one direction, much more in the other, with small inconspicuous tentacles, the whole resembling folds and puckers of rich brown or greenish-brown velvet ; in Porites, the yellow species which forms solid rocks and those great cylinders described above, the beautiful little polyps are generally visible, though small as pins' heads. So rich is a coral mound that a mere enumeration of the forms which comprise it and the briefest reference to their beauties of form and colour would alone occupy a long chapter. The writer can only say that some of his happiest memories are of the hours spent in drifting in calms over coral beds with a water-glass, too absorbed to feel the blazing sun upon his back or the hard boat sides cutting into his arms.

Like the corals the fish of the coral fauna are generally brilliantly coloured, and sometimes strangely shaped as well, and make many reefs a gay scene of active as well as fixed life. Blue of all shades, deep red or pink, black, yellow-brown or green fish abound. Some hover around certain corals among the branches of which they vanish simultaneously on the approach of a big fish and from which shelter they are not dislodged even by one's taking the whole coral into the boat ! Others wander more widely, but never far from the coral into which they disappear when alarmed. Others inhabit the miniature caves, floored with white sand, which abound on the steep slopes. The whole reminds one of the gayest gathering of promenaders, of a brilliance excelling the butterfly costumes of eastern peoples as those do the dullness of western fashions. The approach of a group of big blue fish (*caranx*) passing in single file in purposeful manner, like a file of police among irresponsible loiterers, causes them to vanish as if they had never been.

The marine landscape changes entirely when the breeze dies away and the surface is no longer rippled. The brightly coloured reefs, brown and green, divided from the blue of the deeper water by a shining white line of breakers are as distinct as the squares on a chess-board, so long as the sun is high and the water rippled. In a calm they all disappear completely, nothing is seen below the level water surface, so that navigation among them is impossible. I remember piloting a small steamer to an anchorage among reefs some distance from the shore. In the late afternoon the vessel appeared to be anchored in the open bay, without shelter of any kind until the wind sprang up next morning, when our visitors found themselves in a deep pool almost completely shut in by surface reefs.

So in calms the brilliant colours of the reefs are lost but in their place are the most beautiful pearl tints, brighter yet more tender than those of any gem.

III.—A DRAMA OF CREATION.

So numerous are the evidences of the volcanic foundations of the islands of the western Pacific that it seems almost certain that the atoll rings in their neighbourhood differ mainly in the fact that no trace of the volcano now remains above the surface, or that its summit never reached so high. Earth

movements and the resumption of volcanic activities have doubtless complicated the story and the atolls of other seas and have probably quite different origins; in the Pacific the majority of atolls were probably formed as follows.

Let us first picture the stage. The bottom of the ocean often of the enormous depth of 15,000 feet (2,500 fathoms) deep in the vicinity of a group of tiny atoll sl ands. Into the darkness, silence and freezing cold of these depths are explosions of molten lava and red-hot ash, building up by degrees a great moun-

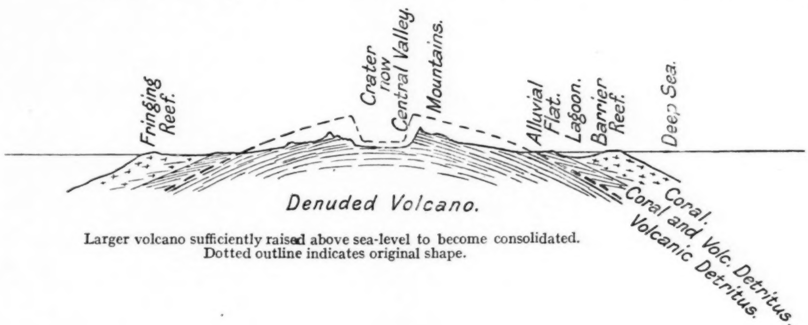
In 1885 a mound about 20 feet high, subsequently much higher;

1889. Reduced in height to 153 feet, most of the cone spread out as a flat 12 feet high and shoals below water;

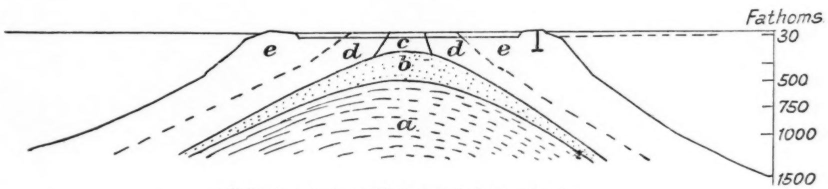
1895. Island only 800 yards long and 40 feet high.

1898. Destroyed by submarine explosion and remained in 1900 as a breaking shoal 100 yards across;

and finally Agassiz reports (though he did not visit the site) that in 1900 nothing but a shoal upon which the sea breaks with violence remains.



Larger volcano sufficiently raised above sea-level to become consolidated. Dotted outline indicates original shape.



Volcanic mound reaching to 500 fathoms of surface.
a. Volcanic material.
b. Pelagic shells and organic remains.
c. First pinnacle to reach surface.
d. This spreads on talus grown in top layer forming a small atoll with shallow lagoon.

tain up to 15,000 feet high, and perhaps emerging another few thousand feet above the sea to form the present volcanic islands, more often barely reaching the surface.

Volcanic Islets.

Whatever may happen in the great pressures of the bed of the ocean it seems certain that, in ordinary depths, the explosions of lava meeting the sea-water results in violent disintegration, so that the island resulting is a mere mass of "ash," often without distinct craters and may be altogether on one side of the centre of eruption. Such was the case when Falcon Island appeared from the sea in the Tonga Group, and in other events of the same kind which have occurred in historic times.

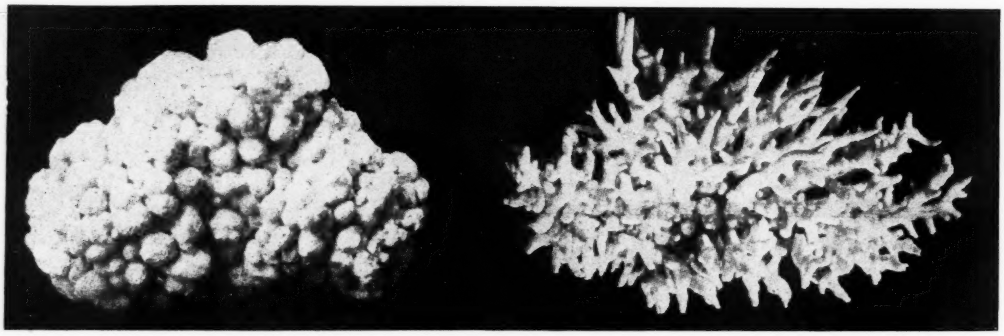
Falcon Island was fortunately visited by Mr. J. J. Lister during his exploration of the Tonga Islands in 1889 and his account in Q. I. Geol. Soc. is an essential contribution to the Geology of the Pacific Islands. Its history is as follows:—

It is almost certain that this shoal will, some hundreds or thousands of years ahead, support a coral ring and eventually a surface atoll, perhaps with inhabited islands. The great rollers of the Pacific will cut it down to a depth of 50 fathoms or so unless, as is most probable, the rim is even now being consolidated and made resistant by organic growth. Long before wave action had brought the shoal to a depth of 30 fathoms its edge must be clear of the looser material and coral knolls and banks be established upon it, thus delaying its further lowering and paving the way for the change from destruction to growth. The ring form of the upgrowing reef will be due, not only to the probability that the edge will give a better foundation in the first place, but because it will always be most under the influence of currents and most free from deposition of sediments. Hence the result of growth will be the formation of coral, shell, algal, and foraminiferal limestones wrapping the whole shoal with a raised edge like a plate.

This, however, is only a special case, where the top of the volcanic mound has reached a height of between thirty fathoms below sea-level—the limit below which reef-forming organisms cease to flourish—and a few hundred feet above. It is obvious that this condition can apply to but a few of the hundreds of atoll rings in the Pacific archipelagos. The cases where the height is above that at which total removal of the mounds by atmospheric and wave actions has been possible, are obvious enough in the volcanic and combined volcanic and limestone islands which abound; the opposite case which is equally or more common, remains to be accounted for. The explosions of "ash" and lava, the implosions of steam in the boiling sea have ceased, leaving a steep sided round-topped mountain summit many fathoms below the level at which ordinary reef formation can begin. This summit, however, grows slowly towards the surface by the aid of two very distinct growths.

BIRTH OF A LAGOON.

The globigerina oozes cover much of the ocean bottom, a kind of soft chalk mud formed by the continuous snowing down into the dark and icy depths of the shells of the small organisms which lived up in the warmth and light near the surface. Though these floating shelled organisms (Foraminifera Pteropoda, etc.) are found everywhere in the surface waters their shells are not found in the greatest depths—the ocean bed is not evenly coated with them as one would expect. Under the great pressures of deeper water the lime of which they consist is dissolved so that less and less of the deposit is formed the deeper the water. So our dark mountain is covered with a fine snow of limestone, the fall of which never ceases, forming a thick cap on its summit but dwindling away to nothing on its slopes. Then again, it is the rule that the summit of a mound is the site upon which all organisms flourish best, and in this case the mountain top may extend into regions where a feeble light can penetrate and the water have a more hospitable temperature. Although it is far too deep for ordinary reef corals, molluscan shells (which often form a large constituent of surface coral reefs) echinoderm spicules and skeletons and especially deep-sea corals are adding to the limestone cap. Finally when a depth of 50 fathoms is reached allies of the reef fauna and certain actual constituents appear and the accumulation becomes more rapid, at 30 fathoms reef corals take possession (lithothamnia—stony seaweeds—have already appeared), and in a short period (geologically speaking) the peak has formed a table-top level with the surface of the sea. From now on the accumulation of deep-water organisms on the higher flanks is so much slower than the outgrowth of the reef, the thin crust of coral, that it may be neglected; the additions to the flanks of the mountain being made up practically entirely of debris from the coral. Consequently the Funafuti boring, for instance, passed through reef material, all formed within 30 fathoms or so from the surface, as deep as it went, nearly 45 fathoms.



Stony seaweeds. Lithothamnia.
[From Fauna and Geography of the Maldives and Laccadives, *Gardiner*.

On this debris the growing surface crust extends outwards. The final result, however, is not the level rock surface which might be expected, for the central parts of the reef dissolve away as the growing edge grows outwards. Whatever may be the main cause of this lagoon formation, whether simple solution or abrasions of rock unprotected by organic growth, by sand laden currents and wave motion, the fact is that every reef is so hollowed out to a greater or less extent, whether dead or living at its edge.

The Elixir of Life.

By F. A. Hampton.

An article which illuminates a very interesting but obscure subject. Biologists hold that the day of the medicine man is over and that the doctor should be as scientific as the engineer. The public on the other hand prefers a blend of mystery with its healing. A psychologist explains why.

DOUGHTY, in his wanderings among the Bedouins, gained some slight tolerance from their fanaticism by treating their many ailments, but he found them bad patients, and wrote: "Now, were I to speak of my medical practice plainly, I think it a desperation to cure the Arabs, and that a perfect physician would hardly be praised amongst them. He is lost whose science is slow, and the honest man of few promises, they will despise his doubts and tentatives. . . . . Their wild impatience looks to see marvels. . . ." This attitude in the patient that Doughty describes so vividly has been met and recorded by almost every physician who has had experience in treating primitive types.

The primitive mind looks that a medicine should contain a magic principle, an intrinsic quality of *goodness* that shall immediately prevail over the *evil* that is, for him, the intrinsic quality of disease. Since he regards the medicine only as a vehicle of magic (and therefore not working through the slow reaction of natural processes) he is naturally disappointed if it does not produce its effects immediately. On the other hand, if he has been strikingly benefited by a medicine, and judges it to be good, he sets no limit to its efficacy and is quite likely to put some on his gun to make it shoot straighter, or hang up the empty bottle to keep wild animals out of his crops.

Magic Remedies.

Something of this attitude of mind appears to-day when we hear people say that such or such medicine is "good for the nerves," or (perhaps with less sincerity) that gin is "good for the kidneys." These ideas sound reasonable enough until we stop to think how a medicine, apart from possessing any magic power, can be good in itself, or make a healthy man any better than he is already. The pharmacologists tell us that the drug acts either by modifying the physiological processes, or by poisoning invading organisms, and that its value, therefore, depends solely upon the desirability in any particular case of such correction as it can bring about.

From this it follows that modern, scientific medicines can seldom cure with dramatic suddenness, they must also be selected for particular diseases and carefully adjusted to the conditions present, demanding a considerable amount of skill and practise in diagnosis which puts their effective use out of reach of the layman. But to the primitive way of thinking all diseases have one common quality of evil. So that if a medicine could be found of sufficient virtue it would cure them all indiscriminately without the labour of diagnosis, and throughout the ages there has always persisted this search for the elixir alongside the more practical, but more laborious specific treatment.

Fountain of Youth.

The quest for the elixir has a certain logical justification, for we frequently find it supported by the belief that disease is essentially due to some diminution of the vital energy of the individual, a radical impairment that alone permits the accident of disease to occur. This may be brought about by black magic and expressed as a belief that the wizard is coming nightly to devour the patient's vitals, to suck the marrow from his bones, drink his blood, or some such fantasy. Or, more sophisticatedly, it may be attributed to a mysterious imperfection in the food, air or water upon which the man is dependent for the stuff of life. In either case this view of cessation of disease is not glaringly unlike the scientific view that attributes infective diseases to a diminution of the individual's resistance, and it leads to the conclusion that if a means could be found to reinforce, what for want of a better term we may call the "vital energy" we should be in possession of the panacea. The search for this "therapeutician magnum" still continues, though now its aim is less ambitious, and from time to time substances or methods, designed on more or less scientific lines to raise the resistance to infective disease are brought forward, though none of them have proved of much value, probably because the nature of resistance is still obscure.

Outside the realms of medicine, elixirs are continually forthcoming, since mankind is naturally eager for

a short cut on the road to health, and however coldly our reason may review the claims of patent nostrums and panaceas, the old primitive belief in their feasibility always ensures a ready sale.

Symbolic Magic.

The pre-scientific search for the elixir seems to have been led astray by the fallacy of taking a superficial analogy as a clue. The sun has been accepted, almost universally, as a reasonable symbol of life and vital energy, so it was thought that any substance resembling it must contain something of its essential quality, and especially if sufficiently concentrated, would impart fresh life and restore the failing vitality. Gold and saffron, especially the former, were two substances of promise. "Perfect health" said Sendivogius the alchemist, "and pure gold are alike," the "aurum potabile" rightly prepared would not only prolong life but "thoroughly cure madness, melancholy, apoplexy, epilepsy, pleurisy, leprosy, asthma, noli-me-tangere and inward imposthumes," any failure to do so was attributed to the difficulty of extracting the real essence or inward quality of the gold.

Saffron has almost dropped out of medicine but gold is still prescribed in America and on the Continent as a "nerve tonic," though it has no desirable physiological action and is an irritant poison except in minute doses.

The common St. John's Wort or tutsan (i.e. *tout sain, "cure all"*) whose golden flowers appear about the summer solstice, has its reputation from association with the sun, and the last relic of the veneration of the Egyptian sun-bath, the sacred scarab, is the use of it by the natives of the Sudan as a sovereign remedy, boiled and decocted in olive oil.

Pearls as a Tonic.

Pearls were believed to be formed by a sun-beam falling on the bed of the ocean and becoming congealed in the subaqueous cold; they were thought to contain the virtues of the sun, so that Cleopatra's potion may have been not merely a gesture of extravagance but a magic draught, probably of rejuvenation.

In modern times electricity, and, more lately, radio-activity have appealed to the popular mind as subtle forms of energy that might be expected to reinforce the "vital energy"; in consequence they have been credited with vaguely beneficent invigorating powers and exploited accordingly.

Masculinity has been accepted as another apt symbol of life, so that a kind of essence of virility was looked for in the mandrake, called the "little man" or "homunculus," from the human-seeming form of its long, forked root. The Chinese use the root of the ginseng and rhinoceros horn in a similar way, while a leaning towards the old faith seems to appear in the ardour with which the public has embraced certain aspects of glandular therapy.

One of the many motives of cannibalism is allied to this search for a medicine to raise the vitality, for it was believed by certain tribes that man's flesh was especially strengthening and could impart something of the dead man's life and vigour, a view that would contain some element of truth if the diet were deficient in vitamines. The use of such a medicine lingered on even into eighteenth century Europe in the employment of powdered skull bones or the moss growing within them as a popular remedy for epilepsy and other diseases.

The True Elixir.

Once it seemed as though the elixir had been found, for a certain alchemist discovered a potion of singularly invigorating effect, but it turned out to be only a concentrated form of alcohol and he died of an overdose.

The Chinese, who have been ardent seekers for the elixir, see in our "Man in the Moon" the figure of a hare pounding for ever at the "Magic Medicine" in a mortar, and perhaps this fantasy is a discreet allusion to the permanence of the quest.

The latest panacea[1] comes from America, and, whatever its virtues may prove to be, it is significant that it follows the old historic lines of the elixir. The discoverer postulates that "syphilis in one form or another is at the foundation of all diseases" ("The Abrams method in Practice" by Burton W. Swayze), and that if there were no syphilis there would be no disease, thus attributing to all illness a common fundamental principle of evil, for to the popular mind syphilis is pre-eminently the "evil disease."

The nature, severity and location of the disease is learned from a mechanical examination of a drop of the patient's blood, for, as the inventor says, "a drop of blood with its countless billions of electrons is a condensation of the multitudinous vibrations of the body," a view that suggests the primitive identification of blood with "life."

The disease is cured by the application of "electronic vibrations," a phrase echoing the modern theories that consider matter and energy in terms of electrons, though its meaning is obscure.

1 The oscilloclast of the late Dr. Albert Abrams, of San Francisco.

Some Persian Rugs.

By Edward Cahen and H. Peckham.

PERHAPS the greatest charm of the modern home is the present fashion for collecting Persian rugs, they add such an air of distinction to a room. It is, however, curious how very little most of the collectors seem to know about their treasures. Even their country of origin seems to be blindly assumed. Now one of the first discoveries the collector with a slightly more inquiring mind makes is that something like half the rugs have never seen Persia at all. A glance at the map of Asia will soon convince him of the truth of this statement. He will find that the names of the places after which the rugs take their names are spread over a very considerable tract of country. It is of course true that there are places in Persia from which rugs come, such, for instance, as Shiraz—the home of Sadi—Kirman, Sinna, Tabriz, to mention but a few which at once occur to the mind. These places have been famous for their rugs for centuries. But the dealer will often describe as Persian rugs which come from Dagestan, Shirvan and Kuba, places all of which are in Trans-Caucasia on the shores of the Caspian sea. He does this with no intention to fraud for these rugs are in no way inferior in beauty or value to those of true Persian origin. It is somewhat startling to note that the most beautiful of these, the rugs of Shirvan, come from the neighbourhood of a town associated in our minds with gushing oil wells and crude petroleum rather than with beauty—Baku.

The sombre but very beautiful rugs from Baluchistan and those of Herat in Afghanistan, Bokhara and Khiva in Turkestan may be called Persian, but never saw Persia and there are even magnificent rugs in blue and old gold made in China which might conceivably be passed as Persian by dealers in oriental carpets.

Identification.

To be able to state definitely where a rug was made is purely a question of experience and a knowledge of certain broad characteristics in design and detail in workmanship peculiar to the different districts. To take a simple instance the rugs of Shiraz often show three large diamonds down the centre with an edge like a barber's pole in two colours. The texture of these rugs is always soft and silky. The designs of the Shiraz rugs, however, show a very wide range.

The rugs of Sinna have a very harsh and close weave and this in conjunction with a peculiar brownish-red dye, a fringe at one end and a selvage at the other serves as a rough guide to their district. The rugs of Kirman have a delicate floral design in blacks and greenish-yellow.

Trans-Caucasian rugs are characterised by their geometrical patterns, often in steps and a fondness for indigo blues is also to be looked for.

The rugs of Baluchistan are usually black with a very deep red and fawn picked out with small but startling points of white.

Bokhara produces chiefly carpets, not rugs, in which red of a lighter shade than that used in the Baluchistan rugs predominates. The pattern is often in octagonl medallions.

Most of the carpets were made for floor coverings or to throw over the broad divan on which the oriental squats as if it were the floor.

Prayer Rugs.

There is one class, however, made for a special purpose, which is often easy to recognise—the Prayer Rug. The Moslim prays in three positions. First he stands with his hands raised, then he kneels and finally from this position bows twice in succession until his forehead touches the ground. This action is Jewish as well as Mohammedan and is described in the Old Testament (Nehemiah 8, 6). Prayer, furthermore, should be made in a clean place—that is why the tourist may not enter Santa Sofia in his dirty boots—and special rugs are accordingly made to ensure that the faithful, saying their prayers for instance in a railway station, may have a clean space in which to say them. The dimensions of such a rug would naturally be about four feet long and three feet wide. The design on such rugs is always a rough representation of the "Mihrab," the niche which in every mosque shows the direction of Mecca.

Occasionally there are designs in the top of the niche to indicate the proper positions of the hands, lips and forehead.

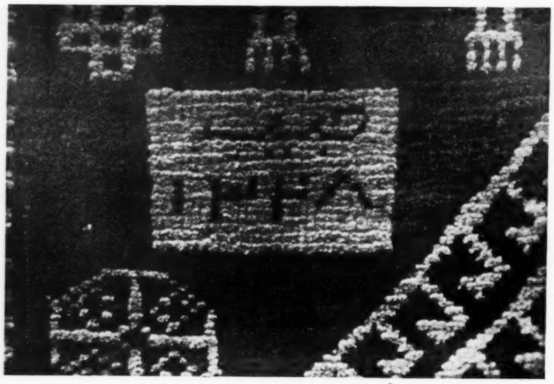
How the Rugs are Made.

Oriental rugs are made on an upright loom. The warp is set up first of all and this varies a good deal as regards material in the various districts, being sometimes of wool, sometimes of linen and sometimes of cotton. On to this a row of knots of the material

of the pile is tied. Then the woof is thrown across once or twice and another row of knots tied. This process is repeated row upon row, the design being gradually evolved in the different colours. The length of the pile is determined and cut after the knots have been tied. The material of the pile varies considerably and may be of wool, silk, camel's-hair or mohair. It is obvious that the number of knots to the square inch will determine the texture of the rug. This together with the kind of materials used and the manner in which they are combined, including the form of the knot by which the pile is fastened gives the expert the clue to the district in which the rug has been made, if he is unable to fix it by the more simple means of design and colour such as those which have been indicated above.

Date of the Rugs.

The question of the antiquity of their treasures has a great fascination for some collectors and it is of interest to see how the date of a rug may be fixed.



Signature and Date on Shirvan rug.

Very few of them are actually dated, though from time to time a date is found neatly woven into the border. These dates, however, can only be read by the initiated as they are written in Arabic numerals with the year starting from the Flight (Hegira) of the Prophet from Mecca in the year A.D. 622. It is quite easy to transpose the year A.H. (Anno Hegiræ) into A.D. near enough for all practical purposes, but it must not be supposed that this can be done by simply adding 622 to the Arabic date, because the Moslim year is ten or eleven days shorter that the solar year. If, however, we subtract 3 per cent. from the year A.H. and then add 621.6 the resulting whole number gives the year A.D. with an egligible error. The Arabic numerals are easily recognised, they are I 3, 2, 8. The numerals read from left to right as ours do. It is advisable, however, for the collector, should he come across a dated rug, to have a look at the back of the rug, as unscrupulous dealers, knowing the desire for antiquity, often do not hesitate to alter this to give a fictitious air of antiquity. An alteration invisible from the front may easily be detected from the back. In the Victoria and Albert Museum at South Kensington there is a Persian carpet from the mosque at Ardebil in north-west Persia, which is one of the masterpieces of the carpet maker's art and bears a date late in the 16th century.

Apart from these few dated rugs it is next to impossible for anyone but an expert to arrive at any idea of date for the patterns of each district are traditional and seem to vary but little for many hundreds of years.

New Discoveries in Palæolithic Art:

Rare Clay Figures found in French river Cave.

Although there can be little doubt that the people of the Old Stone Age, of whose remarkable artistic abilities we have evidence in the rock paintings and carvings of the palæolithic caves in the South of France and Northern Spain, must have modelled in clay at least as freely as they carved in ivory and bone, until recently only one instance of the use of this medium had been discovered. In 1912, M. le Comte de Bégouin found a clay figure in a cave known as the Tuc d'Audoubert in the South of France. The perishable character of the material unless fired, a process with which our palæolithic ancestors were probably not acquainted, is no doubt responsible for their scarcity. In a recent exploration of a cavern in the commune of Montespan near Saint-Martory (Haute Garonne), through which a subterranean stream runs for some 1,200 metres, M. Norbert Casteret, a student of Toulouse University, penetrated by diving beneath a rock which projected below the surface of the water to a part of the cave which had not hitherto been visited, and in a side gallery found a number of rock carvings and clay figures which are described in *La Nature* of March 8th. The rock carvings include figures of bison, deer, horses, ibex and other animals not determinable with equal certainty. In the centre of one group was the head of a man. In the clay at the foot of the rock was a variety of marks, including holes made by fingers and by the claws of a cave bear. Here there were also a number of clay figures both in the round, and attached on one side to the wall of the cave—horses, and three lions or tigers which were 1.70 in length and a metre high. For a crouching bear a real head had evidently been used as the skull lay between the paws. About twenty models, much damaged by water, were scattered about, but there were several fine examples of horses well preserved. The magical intention of the artist was clearly indicated by the fact that the bear, and the lions or tigers, were covered with holes representing javelin wounds, intended both as a forecast and as a guarantee of success in hunting.

The Royal Society's Demonstrations of Pure Science at the British Empire Exhibition.

By Hugh Pollard.

WEMBLEY is a word which carries a variety of implications. To the schoolboy it may be visualised as the Giant Switchback. The Colonial sees in it the blazoned publicity of his own fertile Commonwealth. The Civil Servant dreams of a gratifying flow of newly minted O.B.E.'s.

Switchback and Butter Palace, reinforced concrete, power presses, loudspeakers—all these wonders that bring the folk of the four quarters of the earth to stare and pride themselves on the attainments of man are laboratory bred ; offspring of Nature sired by Science.

The reader of DISCOVERY will find his interest in the section devoted to The Royal Society's Exhibition of Pure Science. It is not probable that it will be realised by many visitors but in point of fact it is the germ cell of the whole Exhibition. It will attract a curious medley of people, some weighty in the social scale, some negligible, yet all brethren of one great intelligent brotherhood.

DISCOVERY is read by professors, by scientists outside academic circles, by teachers, doctors and all sorts of professional men, yet more than half the best and most encouraging letters we receive are written by working men ; miners, artisans and mechanics. Men whose opportunities may have been few but whose intellectual courage is indomitable. Their desire for knowledge is no mere dilettantism, no pleasing hobby of a well-educated man, but a living ardent passion as vigorous and fundamental as any spiritual element in man.

" These are the people to write for ! " said one of our most eminent contributors, glowing with enthusiasm when I showed him a few casual letters ; so in the same way the Royal Society—the finest intelligence in Britain, probably in all the world, has arranged its exhibition not for the expert and the specialist but for the ordinary man.

It's a thing to think over and be appreciative of. And it is so sensibly English. The Germans would have done it so that nobody except an expert could understand a thing. The Russians would probably condemn the exhibits as demonstrating a lack of equality, the gold atom—identified with Capital—having a regrettably higher atomic value than that of Aluminium which might symbolise the peasant, but here in England despite the trumpeting of class warfare by idiots on both extremes of the social scale we find the best scientific brains saying to the masses come, look—and do not be content with marvelling but set out to learn. We will do all we can to help you. That is the true spirit of Science.

The Royal Society's exhibit will be not only an exhibition of apparatus but demonstrations of many of the most important experiments have been arranged. The public will therefore enjoy the privilege of attending at Wembley what is tantamount to a repetition of demonstrations given before the Royal Society itself.

The *précis* of exhibits, in fact the bald catalogue, comprises well over a hundred type-written sheets, some twenty-five thousand words, so it is impossible to hope to give any real indication of the wealth of material available. The demonstrations will not all be simultaneous but will be arranged over the months during which the exhibition is open.

Physics.

Now what are the most important exhibits from the point of view of public interest ?

The Astronomer Royal will show the photographs that proved Einstein's Theory of Relativity.

Sir J. J. Thomson, O.M., F.R.S., is a great name associated for all time with the electron, the ultimate particle of negative electricity. Some of the historical apparatus used by Crookes and Thomson will be shown and there will be demonstrations of discharges in rarefied gases. Thermionics, the discharge of ion-electrons from hot bodies will be demonstrated in their application by Dr. J. A. Fleming, F.R.S., to the development of the triode wireless valve. Professor Lindemann, F.R.S., deals with photo-electricity, and there will be demonstrations of how light from a star is measured.

The work of Sir Ernest Rutherford, F.R.S., the leading authority on Atomic Structure is represented by a complete display of apparatus illustrating his researches on radium and radio-active materials, with particular reference to the a-particle and its bearing on Atomic Structure. The exhibit will include Mr. C. T. R. Wilson's apparatus for photographing the track of the particles in vapour, with demonstrations.

Next comes the Origin of Spectra, an exhibit arranged by Professor A. Fowler, F.R.S. and others. A particularly important exhibit. The exhibits will include the apparatus for X-ray spectra developed by Sir W. H. Bragg, F.R.S., and his son Professor W. L. Bragg. Demonstrations, including band spectra of helium, crystal X-ray spectography, wave-length spectography, etc.

The identification of minute particles of unknown materials in glasses, glazes, etc., by new methods of microscopic examination will be a feature of the exhibit. Resolution of Fine Structure organised by Sir H. Jackson, F.R.S. and Mr. Conrad Beck. On view from August 1. Another microscopical exhibit is the measuring microscope shown by the National Physical Laboratory which reads to 0.00001 of an inch.

The ultra-micrometer devised in 1920 is a novelty outside the inner circle of physicists. In essence it consists of a variable plate condenser. Through leverage the plates are brought closer together and the resultant change in capacity causes alterations in the frequency of an oscillating valve circuit. One ten millionth of an inch can normally be measured and under special conditions ($\frac{1}{200}$) millionth of an inch can be indicated.

Biology.

The foregoing indicate a few—only a few of the exhibits on the Physics side. The exhibition of the Chemistry section is no less interesting, while Geodesy, Time, General Meteorology, Hydrology and Atmospheric Pollution all figure largely with displays of apparatus and demonstrations of their use which will be dealt with in a future number.

Biology will attract as much attention as Physics or Chemistry, and the Biological section is devoting a great deal of attention to the demonstration of the use of Biology as a basis for the Physiological application. Experiments on living tissues will be shown.

Casts of the Piltdown and Rhodesian skulls will also be found in the Natural History Museums section and there will be exhibits showing both fossil evolution and modern synthetic experiments including that of sex reversal in the common fowl, this latter consisting of photographs of the historic hen and microphotographs of the reproductive glands.

Botany will be under the authority of Professor A. C. Seward, F.R.S., and will deal not only with individual species but with the results of scientific expeditions to various territories such as Greenland and demonstrate how the varying climatic epochs can be deduced from fossil vegetation. An interesting and instructive exhibit will be that showing various methods of preserving botanical specimens including Fungi and Algae. Another is the electrical apparatus for recording the breathing processes of plants. It will be shown working.

The descriptive catalogue of the exhibits will rank as one of the most remarkable books on record. It explains the origin, development, and use of the infinite range of apparatus and material displayed and is within its limits a guide to the whole realm of modern scientific discovery.

The Exhibition as a whole is to demonstrate the resources of the British Empire. It it shows this one quarter as well as the members of the Royal Society have planned their demonstration of the glorious work of British scientific workers, it will justify its claim to be the most wonderful exhibition the world has ever seen.

Correspondence.

To the Editor of DISCOVERY

DEAR SIR, Your statement in DISCOVERY for March 1924 (p. 58) that rubber was discovered by La Condamine in 1736 impels me to remind you that this substance became known to our civilization more than two centuries before this date.

Peter Martyr was attached to the court of Ferdinand and Isabella a few years before the voyages of Columbus, and such was his interest in the explorations in the New World that his house was visited by participants from sailors and camp followers to admirals and cosmographers. There was placed in his hands specimens not otherwise officially viewed, and a first-hand knowledge of many important features of the natural history of the West Indies and Mexico was gained. Further facilities came by appointment to the India Council. Before his death in 1526 he had recorded observations on nearly every plant native to these regions which has become economically important; maize (3 varieties), potatoes (8 kinds), maguey, chicle, rubber, cassava, tobacco, Brazil wood, pineapple, banana, guava, sisal, etc.

He says concerning the people encountered by Cortez in Mexico*, " but the most popular game among them, as amongst the people of our own islands, is a game of tennis. Their balls are made of the juice of a vine that climbs over trees, as hop vines clamber amongst the hedges. They cook the juice of these plants until it hardens in the fire, after which each one shapes the mass as he pleases, giving it the form he chooses. It is alleged that the roots of this herb when cooked give them their weight; at any rate I do not understand how these heavy balls are so elastic that when they touch the ground, even though lightly thrown, they spring into the air with the most incredible leaps. Etc."

A hard rounded mass of old rubber was brought to light in excavations on a prehistoric village site near Tucson, Arizona in 1910. This material might have been traded northward along the western coast of Mexico.

It is highly probable that records of the use of rubber gums will be found in Aztec and Mayan records.—I am, Yours very truly,

D. T. MACDOUGAL, *Director*.

DESERT LABORATORY, TUCSON, ARIZONA.

April 1, 1924.

Martyr, Peter. De Orbo Novo: The eight decades of Peter Martyr D'Anghera. Trans. by F. S. MacNutt: G. P. Putnams Sons, New York: See pp. 204, 25, 1912.

Ways and Means in Archæological Research.

By E. N. Fallaize

How students are recruited and research expeditions begun.

ARCHÆOLOGY, once the leisure-time pursuit of the enlightened amateur, has become in little more than a generation a highly specialized branch of study which, at any rate on its practical side, is becoming as exacting in the qualifications it requires from its devotees as any profession. Not only must they undergo a severe training in method, and acquire the habit both of observing accurately and of recording carefully what they observe, but in order to interpret the data they recover from the past, they need a rare gift of imagination and insight, severely disciplined by wide and accurate knowledge. For, it must be remembered, the ultimate aim of archæology is not merely to get together a number of objects which are interesting for their intrinsic value, their artistic merit, or their mere antiquity, but by interpreting these objects and by demonstrating their use, their relation one to another and their technological and artistic qualities, to reconstruct the history, racial affinities, and, as far as possible, the life, mental, moral, and material of the people by whom they were used.

Specialised Knowledge

In addition to the more strictly archæological problems with which the investigator is concerned, there are many technical points which may arise in the courses of an investigation. These may vary from a question as simple as that of the material from which a stone implement has been made to a highly complicated problem in technique such as may be involved in the composition or method of manufacture of a metal object or a pottery glaze, upon which important questions of origin or relation may hinge. In such questions, expert assistance may be invoked from the chemist, metallurgist, or specialist in other branches of knowledge, but when working in the field this may be unattainable and involve loss of opportunity for research along lines which expert knowledge would have suggested. Therefore, the wider the archæologist's knowledge of such technicalities, the more successful he is likely to be in excavation. A recent writer in the United States has pointed out the serious errors in the conclusions of archæologists owing to their failure to identify correctly animals represented in relics of early and primitive peoples. As such animal forms are often made the basis of arguments as to the origin and history of different types of culture, such errors are of more far-reaching consequence than might be thought.

The preservation of objects found, such as ancient bones, objects of wood and other material perishable through age, involves a training in the use of preservatives as well as the exercise of some ingenuity, while conducting an excavation of any magnitude in a tomb or other building requires some mechanical knowledge both to carry on the work in safety as well as to remove obstacles in the form of heavy falls of masonry or stone which may be encountered. Not the least remarkable feature in the excavations carried out by Sir Arthur Evans over a number of years in the Minoan Palace at Knossos, has been the way in which engineering and architectural difficulties have been overcome, so that not only have the buildings been cleared as the work progressed, but they have to some extent been restored to what they once were. It should, therefore, be no matter of wonder to the lay mind that an important investigation such as that of the tomb of Tutankhamen should require the co-operation of a considerable number of experts in different branches of science, and further that archæological investigations are, when carried out thoroughly, one of the most costly forms of scientific research. The laborious task of digging is not one of the least expensive items at present rates of labour.

Important Details

From what has been said it follows that archæological investigations such as those which are now being carried on in Mesopotamia, Egypt, and elsewhere, involve both scientific training and financial resources of no mean degree. Yet evidence which may be of immense importance for our knowledge of antiquity lies within the reach of most if they know how to look for it. The nearest gravel pit or the gravels of an adjacent river valley may yield implements of the Old Stone Age. Arrow heads of Neolithic Age are picked up in numbers from the surface of ploughed fields, while in this country, as well as in the East, a potsherd may yield valuable information to those who can interpret its story. The present excavations at Ur and Tell el-Obeid in Mesopotamia

are the result of a visit paid by Capt. Campbell-Thompson during the war, who drew his first deductions as to the importance of the site from the surface indications of pottery and implements alone.

Scientific archæological investigation rests on a basis of two principles—observation of position and observation of association. When an implement, piece of pottery, or other archæological specimen is found, the first essential is that its exact position should be recorded. As one authority has said in speaking of the near East where on an archæological site potsherds may be thickly scattered on the ground, to pick up a potsherd, carry it for a distance and then throw it away without record, is to tear a page from the book of history which can never be replaced. He might have emphasized the way in which it may mislead the next comer who finds it.

The object of noting position is not only to afford evidence for the distribution of the type of specimen found, a matter of great importance for the question of origin as well as for questions of movements of race and culture—it is also all important for determining date and age. In the case of an implement found among river gravels, the height above the valley bottom indicates at what stage in the erosion of the valley the gravel was deposited. The higher the gravel, the older the implement, that is, if other evidence does not exclude their having been deposited contemporaneously. In the case of an implement from a gravel pit in which the geological strata are clearly exposed, its age will be indicated by the stratum from which it comes. Similarly, if the specimen is found below the surface of the ground, it is equally important to record the exact depth. Many archæological sites are indicated by mounds. If they have been occupied for any length of time and have not been disturbed, the trenches which are dug into or across the mound are found to cut into or through more or less clearly defined strata, each representing a period of occupation and according to their thickness giving some indication of the relative length of that period.

Absolute Dates.

A record of the stratum in which any given object is found fixes its date in relation to objects found in, at the same level, or in earlier or later strata. Some archæologists have even utilised this evidence to indicate an absolute dating, but this is precarious. It was on such data that Dr. Pumpelly assigned a date of 8000 B.C. to the lowest neolithic stratum excavated by him at Anau in Turkistan; but whether it affords any indication of absolute date in years or not, record of undistrubed stratification is essential for the relative date. This brings us to the second principle, that of observation of association.

Just as the geologist in determining the age of a geological deposit is guided by the fossils which he finds in it, determining the date by those which are characteristic of a given geological horizon, so the archæologist must observe and record all the objects found together in any given stratum. It is here that his knowledge of his subject comes to his assistance, for should any of these be "characteristic," the archæological date is determined. To take the simplest case, the occurrence of a bronze weapon in an interment will at once give *prima facie* grounds for assigning that burial to the bronze age. The type of bronze weapon, for instance a leaf-shaped sword, may enable him to determine the date even more precisely, and decide whether it is early or late Bronze Age. Always provided, however, that other objects associated with it do not indicate conflict and point to its being a survival into a later period. Most commonly, however, the class of evidence upon which the archæologist relies is that of pottery, whether whole, or in the form of sherds. The study of the classificatious, sequences and affinities or types of pottery in form, technique and decoration is in itself alone no inconsiderable part of an archæologist's training. But whatever may be the kind of evidence available, its utilisation depends upon comparative study of types to be pursued only in museums. In most of the museums of this country there is material, especially of local origin, which affords assistance to the student; but in the collections attached to teaching institutions such as the Schools of the Universities, from which nowadays the majority of archæologists are drawn, there are type series specially arranged for purposes of instruction. The great national collections in the British Museum and in the national museums of Scotland, Wales and Ireland, both in quantity of material and in arrangement, are of incalculable assistance to the student.

Field Work.

In Great Britain organised field work is a matter of private or semi-private enterprise. The financial assistance from national sources, though available for some branches of scientific research, is not given directly to assist archæological investigation. Excavations may be undertaken by a private individual at his own expense, as Gen. Pitt-Rivers carried out the extensive excavations on his own estate at Cranbourne Chase in Dorsetshire, but more commonly

they are carried out with the co-operation of some organisation such as a learned society. Excavations at the Roman site at Silchester and at Stonehenge were carried out under the auspices of the Society of Antiquaries, the Iron Age Lake Village at Glastonbury was excavated under the supervision of the Somersetshire Archæological Society, with the co-operation of a Committee of the British Association, and numerous other cases could be mentioned in which the British Association, either alone or in co-operation with other bodies, has provided funds and personnel for archæological research. It is usual for the Society supervising the work to appeal for funds, both to its own members and to the scientific public.

In the case of excavations abroad, particularly in the Near East, funds may be provided and workers recruited in a variety of ways. For work in Egypt and Palestine in particular, societies exist in this country and in America, funds being provided from the subscriptions of their members who, in return receive a printed report of the work issued periodically. These societies carry on their work regularly from year to year, but occasional expeditions for work on special sites are sent out by Universities or Museums, as the excavations now being carried on at Ur in Mesopotamia are the work of a joint expedition of the University of Pennsylvania and the British Museum. In the case of Universities, owing to lack of funds, the expedition frequently depends upon the private benefactor, as in the case of the Weld-Blundell expedition of Oxford University now working at Kish in Mesopotamia.

Archæological Societies.

More rarely the private individual works independently, as Lord Carnarvon and his predecessor, Mr. Theodore M. Davis, excavated in the Valley of the Kings for a number of years, and Sir Arthur Evans, to a great extent though not entirely, has carried out his excavations at Knossos. In this connexion a case may be mentioned which is specially significant of the indifference which is sometimes shown to the efforts of the individual. The Maya sculptures and casts of sculptures from temples in Central America were brought home by Dr. A. P. Maudslay and presented to the nation. The cost of the expedition was not less than £10,000, which was defrayed entirely out of his own pocket. The expedition was a triumph of organisation and involved innumerable hardships owing to the climate and difficulties of transport. Yet these valuable records of monuments, many of which have now disappeared, were allowed to lie unseen, almost forgotten in a cellar for over twenty years, until, largely by the insistence of the officials themselves, the expense of exhibiting them in the British Museum was faced.

Schools of Archæology.

At the end of the last century a new type of archæological institution was formed :—The School of Archæology, resident in the country in which investigations were being carried on. Of these the first was the British School of Archæology at Athens, which has been followed by the School at Rome and the School in Palestine. There is also a British School in Egypt which does not, however, work on quite identical lines. Other countries have followed this example, and the American School at Athens in particular has done valuable work. The United States, indeed, has followed this model in founding a School of Archæology in Mexico. These Schools are becoming increasingly important, especially now that it is more difficult for foreigners to obtain the concessions from the various Governments which are necessary under the Antiquities Laws before archæological investigations can be undertaken. They are supported by voluntary subscriptions and also by the fees of students who reside and study at the School under the supervision of a staff who guide and otherwise assist them in their work. It is from these students, university graduates, some holding university scholarships, that most of the recruits to archæological studies in the field are now drawn, and to them we shall look for additions to our knowledge of the past in an increasing degree in the years to come as the need for the trained specialist becomes more insistent.

IN SEARCH OF THE BITTERN

Readers of DISCOVERY will hear with pleasure that Miss E. L. Turner, the well-known naturalist and one of the first women Fellows of the Linnean Society who has gone off to Scoult Head Island, Norfolk, for a six months' spell of bird watching, has kindly promised to contribute some articles on her work to DISCOVERY.

A BOOK ON PUMPS

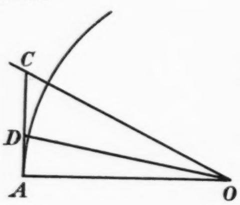
What is believed to be the first standard reference work on "The Modern Theory and Practice of Pumping," will be published next week. Written by Mr. Norman Swindin, A.M.I.Mech.E., it is a comprehensive story of viscosity from an industrial point of view, and a description of industrial viscometers, their standardisation, calibration and use. A new theory and formulæ for the air lift is given together with studies on the efficiency of displacement pumps, calculations of film resistances as met with in practice. There are chapters on the pumping of oil, corrosive liquids and specially thick substances. The work concludes with full bibliography of recent works and papers. The oil, gas and margarine industries, to mention only three, will find new formulæ contained in this work a direct help to more economical and more efficient working. The book will be published by Ernest Benn Limited.

π and James Smith.

By E. R. Brown.

THE problems of the quadrature of the circle and of the rectification of the circle have, for about 3,600 years, occupied the attention of many mathematicians and of perhaps even more pseudomaths, as De Morgan called those who imagine themselves to be mathematicians upon insufficient grounds. The first of the two problems is the construction of a square having exactly the same area as a given circle, and the second is the construction of a straight line having exactly the same length as the circumference of a given circle. The Greeks knew that corresponding lengths in figures of the same shape were proportional, and since all circles are of the same shape, they realised that there must be a constant ratio between the circumference of a circle and its diameter. Archimedes (287-212 B.C.), the greatest of pre-Renaissance mathematicians, proved that a circle is equal in area to a right-angled triangle in which one of the sides containing the right angle is equal to the radius, and the other to the circumference, of the circle. Thus he showed that the solution of one of the two problems would immediately yield the solution of the other.

In the year 1700 B.C. a clerk, Ahmes, of the king Raaus stated that the area of a circle is equal to that of a square whose side is the diameter diminished by one ninth, which implies $\pi = 3.16$. This value which is more accurate than the 3 of the Babylonians and Jews (2 Chronicles, iv. 2) was probably found by experiment. With the Greeks began a period of systematic investigation; their aim was the determination of the value of π, and their method was the calculation of the perimeters and areas of regular polygons inscribed and circumscribed to a circle.



Archimedes began with the regular hexagon circumscribing the circle; AC is half of one side of the hexagon and consequently $OA = \sqrt{3}$ AC. He then bisected angle AOC with OD, so that AD is half the side of the regular circumscribed dodecagon, and can be calculated by the use of Pythagoras' Theorem. Proceeding in this way, Archimedes obtained the length of the side of the regular 96-gon circumscribing the circle. The circumference of the circle must be less than the perimeter of this polygon and Archimedes was able to deduce that π was less than $\frac{22}{7}$. By applying the same method to successive inscribed polygons, he found that π was greater than $\frac{223}{71}$.

To obtain π correct to 20 decimal places it is necessary to calculate the lengths of the sides of polygons with over 32,000 million sides, yet by the use of this method, Ludolf van Ceulen (1539-1610) calculated π to 35 decimal places. This value was carved on his tombstone, which is now lost; perhaps it has crossed the Atlantic.

Vieta (1540-1603) was the first to express π by means of a never-ending series of operations, for he showed, by considering the relation between the areas of inscribed polygons of 2^n and 2^{n+1} sides that

$$\frac{2}{\pi} = \sqrt{\tfrac{1}{2}}\ \sqrt{\tfrac{1}{2}+\tfrac{1}{2}\sqrt{\tfrac{1}{2}}}\ \sqrt{\tfrac{1}{2}+\tfrac{1}{2}\sqrt{\tfrac{1}{2}+\tfrac{1}{2}\sqrt{\tfrac{1}{2}}}}\ \ldots$$

The improvement of algebraic symbolism and the invention of the differential calculus led to an attack from a different angle, so that during the eighteenth century and the latter part of the seventeenth century a very large number of explicit expressions for π were produced, either in the form of series, infinite products or continued fractions. Thus we have Gregory's elegant series $\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \ldots\ldots$, Wallis' product $\frac{\pi}{2} = \frac{2}{1} \cdot \frac{2}{3} \cdot \frac{4}{3} \cdot \frac{4}{5} \cdot \frac{6}{5} \cdot \frac{6}{7} \ldots\ldots$ and Lord Brouncker's continued fraction $\frac{4}{\pi} = 1 + \frac{1^2}{2+}\ \frac{3^2}{2+}\ \frac{5^2}{2+}\ \frac{7^2}{2+} \ldots\ldots$ Gregory's series converges slowly but Sharp used it to obtain π to 72 decimal places; Machin in 1706 using $\frac{\pi}{4} = 4\left(\frac{1}{5} - \frac{1}{3.5^3} + \frac{1}{5.5^5} - \frac{1}{7.5^7} + \ldots\right) - \left(\frac{1}{239} - \frac{1}{3.239^3} + \frac{1}{5.239^5} - \ldots\right)$ obtained 100 places and the race for the value of π was well under way.

In 1719 de Lagny reached 127 places, while near the end of the century Vega found 140. In 1841 Rutherford soared to 152 places and the pace became hotter. Zacharias Dase working night and day for two months in 1844 scored the double century; three years later Clausen attained 248 places. Rutherford was

spurred on to a mightier effort and in 1853 put himself well ahead with 441 figures, but a new competitor was in the field, and the very same year W. Shanks reached first 530 and then 607 places, while twenty years later he achieved a permanent place in mathematical history by publishing π correct to 707 places of decimals.

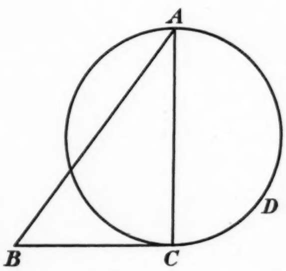
The ratio of the circumference ($\pi\epsilon\rho\iota\mu\epsilon\tau\rho o\varsigma$) to the diameter ($\delta\iota\alpha\mu\epsilon\tau\rho o\varsigma$) was represented by William Oughtred in 1647 by $\frac{\pi}{\delta}$, and the isolated π was used first by William Jones and universally after its adoption by Euler. It is in the very nature of π that a new symbol is necessary for it, for it belongs to the class of numbers called irrational; it is like $\sqrt{2}$ or $\sqrt{3}$ which could be calculated for ever without finding any repeated sequence of numbers. Lambert proved in 1761 that π is irrational. But π has another peculiarity, a peculiarity suspected by Lagrange, for there is no equation with rational coefficients which is satisfied by the value π. Here it fundamentally differs from such irrationals as $\sqrt{2}$ or $\sqrt[3]{2}$ which satisfy the equations $x^2-2=0$ and $x^3-2=0$ respectively. A number with this property is called a transcendental number, and that π is transcendental was proved by Lindemann as recently as 1882.

Behind all this serious work there was a comic-opera background of circle-squarers; from the days of the Greeks until the days of James Smith, once Chairman of the Liverpool Local Marine Board, non-mathematicians devoted themselves to the problem with a pertinacity and a passionate enthusiasm worthy of a mathematician. In 1775 the Paris Academy had to pass a resolution that no more solutions of the problem of squaring the circle were to be examined. De Morgan once gave a lecture on circle-squaring and a member of the audience exclaimed, "Only prove to me that it is impossible and I will set about it this very evening." We always have these romantics with us—to-day, understanding nothing of Newton, they demonstrate the errors of Newton—but James Smith was the greatest knight-errant of them all. For years the mathematicians had been essaying the rescue of the maiden π; he was to be her rescuer.

He began by making copper squares and copper circles and weighing them; he was delighted to find that the ratio between the diameter of the circle and the side of the equivalent square was as 8 : 7. From this $\pi=3.0625$. "These facts appeared to me perfectly convincing and I gave them without hesitation to several friends of high mathematical attainments but I was astonished to find that one and all considered the subject utterly unworthy their serious consideration. They assured me that in the analysis of the circle, the first approximation carried the figure far beyond mine, that there must be a fallacy in my calculations somewhere, that the solution of the problem was utterly impracticable, and that if I valued my own comfort and peace of mind I should abandon the task as hopeless." James Smith found this very disheartening but his love of the truth was greater than his desire for comfort, and unconvinced, he determined to pursue the inquiry further; indeed he wrote that he could not help it, for the subject haunted him night and day.

He worked on; he tested his 3.0625 again and found that there was apparent disagreement. "For an instant, I was unnerved, but fortunately at this critical moment, my presence of mind did not forsake me." Great scientists have frequently found inspiration in the observation of simple facts, as, so we are told, Newton was led to the discovery of gravitation by the fall of an apple. James Smith had a mind of the same sort. He discovered that if he took three consecutive whole numbers such as 7, 8, 9, and subtracted one from the highest and added it to the lowest, he obtained three figures of the same value. His mathematical ability is completely indicated when he says that he tested this again and again and found it always true. This and similar discoveries led him to draw a chess-board of 64 squares and in it to describe a circle. With amazing presence of mind, his fingers no doubt trembling with excitement, he counted the squares within the circle. If π were 3.0625 there should have been 49. There were not 49 but "precisely 50." "A new light instantly burst upon me. The area of the circle is a 49th part more than I imagined. True! I have been labouring under a delusion. I flew to my figures. Will 3.0625 divide by 49? It did. I have it, I exclaimed! The secret which has been hid for ages is now revealed; the ratio between the circumference of a circle and its diameter is exactly $\frac{25}{8}$ or 3.125."

He published a pamphlet and distributed it to all famous mathematicians and on July 14th, 1860, one, who appears under the pseudonym "Eminent Mathematician" kindly offered to point out to James Smith his mistake. Smith sent a new proof:— Let ABC be a right-angled triangle whose perimeter is 3. Let $AC=1$, $BC=\frac{3}{4}$, $AB=1\frac{1}{4}$; on AC as diameter



describe a circle D which by hypothesis shall have a circumference $3\frac{1}{8}$ times the length of AC. Then the perimeter of the triangle will be to the perimeter of the circle as $3 : 3\frac{1}{8}$. That is the essence of the proof without the padding. Eminent Mathematician carefully and at some length pointed out the impossibility of proving a statement from the supposition that it is true. The correspondence continued until, in September, James Smith explicitly denied that the circumference of a circle is longer than the perimeter of any inscribed polygon and shorter than that of any circumscribed polygon. Eminent Mathematician felt it was useless to continue and said so; he received a reply which fills seventy pages of the volume that Smith published the next year. It is very doubtful whether anyone has ever read the whole of this letter.

James Smith wrote to Whewell, Master of Trinity, and to G. B. Airy, the Astronomer Royal who said "It would be a waste of time, Sir, to listen to anything you could have to say on such a subject," a reply which highly incensed James Smith and he compared himself to the persecuted Galileo. He wrote to Sir William Hamilton, to Hooker and to Canon Wilson, at that time mathematical master at Rugby, who replied, "My dear Sir, I have received your two somewhat extended letters and beg to acknowledge them. I cannot say that I have perused them with an attention at all proportionate to their length, but I have been able to perceive that you are able to prove your conclusions by a process of reasoning which is absolutely sound and logical, and that therefore your conclusions are as certain as their premises with which they are in fact identical." Smith was delighted.

In 1868 he again found a mathematician to correspond with him, the Rev. Professor W. A. Whitworth (author of "Choice and Chance"). Whitworth pointed out that if, in the argument he submitted, he replaced his $\frac{25}{8}$ by $\frac{16}{5}$ or $\frac{512}{125}$ he would thereby establish these as values of π. Had he tried $\frac{512}{125}$? "I certainly never attempted anything so absurd," said James Smith, "as to assume such a value of π as $\frac{512}{125}$, which would make the value of π greater than the perimeter of a circumscribing square to a circle of diameter unity." Whitworth then shewed that Smith's argument led to the equality of the arc cut off by a chord of a 25-gon and the chord itself, and it is interesting to follow his attempts to make Smith face this consequence of his thesis. To begin with he ignored it but Whitworth pressed for a reply,—"You do not even tell me whether you are going to maintain the equality of the chord and arc, which, on your own showing must exist, if $\pi=3.125$." Smith:—"Simply untrue. I answer this by putting a question:—Is not the natural sine of the acute angle, in a right-angled triangle of which the hypotenuse and shortest side are in the ratio of 8 to 1, as certainly .125, as the natural sine of the acute angle in a right-angled triangle of which the hypotenuse and shortest side are in the ratio of 2 to 1, is .5?" Whitworth is willing to admit this and inquires the relevance. James Smith begins to lose his temper; "My dear Sir, if you would write less, and think more, the sooner should we be likely to get to the end of our labours, but if you pertinaciously persist in assuming that you have nothing to learn in mathematics, and resolutely determine to take your stand in the ranks of that numerous class who despise wisdom and instruction I can't help it; and there is no telling how long our controversy may continue." Whitworth patiently perseveres:—"But you tell me that the perimeter of a 25-gon is $\frac{25}{8}$ of the diameter of the circumscribing circle and the circumference of the circle is also $\frac{25}{8}$ of the diameter. You must either admit one of these statements to be wrong or else maintain the equality of the chord and arc." Smith:—"I never told you anything of the sort. It is a gross perversion of what I have told you, and I find it difficult to persuade myself that you don't know it. I, of course, admit one of these statements to be wrong, but the statement that is wrong is the coinage of your brain, not mine."

De Morgan made great fun of James Smith in "The Athenæum" and parodied his general method of proof. "To prove that 2 and 2 make 5. Let $a=2$, $b=5$; let $c=658$, the number of members of the House of Commons, let $d=666$, the number of the Beast. Then of necessity $d=a+b+c+1$, so that 1 is a harmonious and logical quantification of the number of which we are to take care. Now b, the middle of our digital system is by mathematical and geometrical construction a mean between $5+1$ and $2+2$. Let 1 be removed to be taken care of, a thing no real mathematician can refuse without serious injury to his mathematical and geometrical reputation. It follows of necessity that $2+2=5$, *quod erat demonstrum horrendum*." As in Euler's proof of the existence of God ("Monsieur $\frac{a+b^n}{n} \doteq x$, *donc Dieu existe; répondez.*") it is impossible to pick out the fallacy; it would have been interesting to see how Smith would have dealt with an argument in his own style. Probably he would have felt no more necessity to deal with it than with serious criticism. He always changed his ground, his is the tragedy of the missed vocation—he was the perfect politician.

The Present Status of the Evolution Theory—II.

By Lancelot T. Hogben, M.A., D.Sc., F.R.S.E.

The second of Dr. Hogben's extraordinarily able articles on what we know about the laws of evolution. It will repay careful reading.

At the time Mendel formulated the fact of segregation in terms of discrete units present in the gametes (sperm and ovum) from whose union a new individual originates nothing was known that would provide a material basis for the genes. Almost simultaneously with the vindication of Mendel's hypothesis by De Vries, Correns and Tschermak and its extension to animal inheritance by Bateson and Cuènot, the observations of de Winiwarter, Sutton, McClung and other workers revealed in the structure of the gametes a mechanism which has now proved capable of fulfilling the conditions laid down at the conclusion of our last article. So spectacular is the way in which the testimony of the microscope has confirmed the conclusions derived from breeding experiment that it now requires some hardihood to refrain from accepting not merely the truth of the particular interpretations of Mendelian analysis but the substantial correctness of extending its conclusions over the entire domain of inheritance in organisms. Therefore before approaching certain recent developments in the factorial hypothesis which are significant for an appreciation of the present status of the evolution theory, we shall pause to consider the material basis of heredity in the light of recent research.

Research Results.

First, however, reference must be made to an important aspect of the phenomena of linkage dealt with in our last article. In the normal (wild) Drosophila the eye is red; among the mutant forms reared by Professor Morgan, there is one characterised by white eyes. A white-eyed male crossed with a wild female gives an F1 generation of red-eyed individuals, the white factor being recessive. In the reciprocal cross between a wild male and a white-eyed female, only the females are red-eyed, all the males being white-eyed. The wild male, in fact, proves to be constitutionally heterozygous for the red factor, producing two types of sperms one of which will fertilise an egg destined to become a female and capable of bearing the red factor, the other which cannot carry the red factor and which will fertilise an egg that is destined to be male. If the heterozygous female is crossed back to a wild male, the female offspring are red, and the male offspring are either red or white in equal numbers. If, on the other hand, the female heterozygote is crossed back to a white male, the offspring of both sexes are of either type, red and white, in equal proportions. These results fall into line on the hypothesis that the red factor is linked with something which, if present in the zygote in dupilcate, leads to the production of a female, and if present in the zygote unpaired leads to the production of a male. Since maleness is the state associated with the single condition, and femaleness with the double component, it is natural to refer to this factor as the factor which determines femaleness. Thus sex is seen to be determined by genetic factors. There is a large group of factors in Drosophila which, like the red-eye factor, are *sex-linked*. We shall return to the question of sex-linked inheritance later.

Cell Structure.

The bodies of animals and plants are built up of millions of microscopic units, the cells. Cells arise by the bi-partition of pre-existing cells, and if the process of cell-division is followed back far enough, we arrive at a single cell. This is the fertilised ovum, which is formed by the union of the sperm and egg. Everything which is implicit in the term heredity must be represented in the fertilised egg; every character which can be said to be inherited must be determined by something present in either the male or the female gametes by whose union the fertilised egg came into being. Breeding experiments led us to postulate material units involved in hereditary transmission, and have indicated some very definite conclusions as to the manner in which these material units must be distributed among the gametes. Consequently it might be anticipated that a microscopic study of the structure of cells would lead to the identification of some arrangement by which the segregation of maternal and paternal factors is effected. Such indeed is the case. To-day it is possible with the aid of the microscope to locate in certain cell organs, the *chromosomes*, the material basis of hereditary transmission with as much confidence as we have in identifying the neurones of the reflex arc, as the structural apparatus of neuromuscular co-ordination. The structure of cells has been studied mainly by means of an elaborate technique including the dif-

ferential staining of the component parts with appropriate dyes after the cell has been killed by suitable methods; but recent advances in the culture of living tissues and the micro-dissection of cells, have made it quite certain that the appearances obtained in this way are not artifacts but faithful pictures—in the main at least—of the organisation of the cell in the living condition.

The essential features of cell structure are as follows. All cells contain a usually spherical vesicular body, the *nucleus*, lying in a viscous substance, the *cytoplasm*. The nucleus of a resting cell appears in microscopic preparations as a vesicle containing a tangle of finely spun threads. At one side of the nucleus is a small area of cytoplasm: the *attraction sphere*, whose separation into two parts heralds the inception of cell division. As the two attraction spheres separate they appear to draw out the surrounding cytoplasm into a spindle of fine fibrils. Meanwhile, changes have taken place in the nucleus itself. The tangle of fine threads has resolved itself into a number of readily distinguishable filaments which become progressively shorter, assuming the appearance of stout rods or blocks staining deeply with basic dyes. These rods are known as the chromosomes. They arrange themselves on the equator of the spindle and split longitudinally in halves. The halves pass to opposite ends of the spindle, and while the division of the cytoplasm completes itself, they spin out again into fine threads, from which the nuclei of the daughter cells are built up. Thus each of the chromosomes in the nucleus of one cell generation is structurally continuous with a corresponding chromosome in that of the preceding and succeeding cell generations. In every species of organism the number of chromosomes which can be counted in dividing nuclei is constant. It is obvious that to maintain this constancy there must be some arrangement to provide for the halving of the number of chromosomes in the formation of the gametes; otherwise it would be doubled at fertilisation.

Function of the Nuclei.

And it is found that the nuclei continue to divide in the manner described consistently excepting at the last division but one of the germ cells preceding the liberation of the gametes. As far as the nuclei are concerned, the last two divisions of the germ cell are similar in both sexes. However, whereas in the male, the last two divisions of any male germ cell result in the formation of four functional spermatozoa, in the case of the female one functional egg is produced, the three other nuclei degenerating and constituting what are known as the polar bodies.

The penultimate division of the germ nuclei is preceded by the lateral approximation in pairs (synapsis) of the constituent chromosomes so that when the chromosomes proceed to split up the spindle one member of each pair passes to each daughter nucleus. The succeeding division appears in general to be normal, so that each gamete has half the number of chromosomes characteristic of the dividing cells of the species. At fertilisation the normal number is thus restored, and each ordinary cell of the organism has therefore a chromosome set of which half the components are paternal in origin and half maternal. Now in many animals and plants it is possible to distinguish among the chromosomes pairs of different sizes and shapes—this is the case, for instance, in Drosophila—and it is possible to see that each gamete receives one representative of each pair.

Upon reflection, this fact is seen to be of first-rate significance to the search for a material apparatus for genetic segregation. Consider as a concrete illustration, the case of the stone fly Perla, as described by Nakahara (1919). In the unripe germ cells of the male the chromosome complex consists of ten elements differing *inter se* in the following way: one pair, a, a^1, are rod-like and equal, two pairs, b and b^1, are V-shaped and equal, one pair, c, c^1, are much smaller and spherical in contour, the fifth pair being composed of unequal rods X and Y, whose special significance will become clear at a later stage. After reduction the sperms contain five chromosomes, viz.: a or a^1, b or b^1, c or c^1, or X, or Y. Similarly the female gamete will contribute one member of each pair to the fertilised egg which hence possesses five pairs of chromosomes like its parent. The nucleus of the fertilised egg divides so that the daughter nuclei of the first cleavage receive a representative of each of the chromosomes, and this process is repeated again and again in the upbuilding of the embryo. Each cell of the individual contains five pairs of chromosomes, one member of each pair being derived from the father and the other from the mother. As the result of reduction each gamete receives one component of each pair, that is to say, *the formation of the gametes involves the segregation in each pair of chromosomes of its paternal and maternal components.* In the behaviour of the chromosomes, therefore, we have the precise condition of hereditary transmission, as revealed by Mendelian analysis, realised. Mendel's law leads us to regard the structural characteristics of the organism as dependent in hereditary transmission on material units derived from both parents, maintaining their integrity through all the cell divisions which intervene between fertilisation

and a new generation of gametes, and finally segregating before the gametes are actually formed, so that with reference to any corresponding pair a gamete can receive either the maternal or the paternal component, but not both at the same time. The observation of cell structure by microscopic methods shows that in reality there do exist structure which behave in cell division fertilisation and gametogenesis in this identical fashion. These structures are the chromosomes, and the chromosomes are the only identifiable cell organs whose behaviour conforms to the law of segregation.

It has been mentioned that in some cases a given pair of allelomorphs are found to segregate independently of one another, so that we are led to postulate separate material units on their behalf. In other cases we have seen factors belonging to different allelomorphic pairs associated in transmission in such a way that would suggest a common unit of structure as the basis of their distribution among the gametes. Both phenomena find an interpretation if it is assumed that in the one case the factors are located in different and in the other in identical pairs of chromosomes. In the fruit-fly, Drosophila, which breeds prolifically at a most prodigious rate, Professor Morgan has obtained in his cultures since 1910 several hundred mutant forms exhibiting factorial differences with respect to the parent stock. These have been bred one with another, and in consequence the fact has emerged that all the mutant factors may be classified in four groups such that a given factor shows linkage with members of its own group but independent segregation with reference to factors belonging to the other three groups. Now in Drosophila the number of chromosomes is eight, that is to say, there are four pairs of chromosomes corresponding precisely with the number of groupings of linked factors. Considering the large number of factors which have been studied in Drosophila, the correspondence is a very remarkable one ; and no animal or plant has yet been shewn to possess a number of linkage groups in excess of the chromosome pairs in the dividing nuclei of its cell.

It will be as well here to recall the inferences as to the material basis of inheritance that were drawn from breeding experiments. Mendelian analysis leads us to postulate material units :—

(i) Structurally continuous throughout all the cell divisions of the germ cycle.

(ii.) Present in duplicate in the fertilised egg :

(iii.) Segregating into maternal and paternal components at some point before the ripe gametes are formed.

(iv.) Present in the germ cell in pairs which numerically correspond with the number of linkage groups.

These conditions are precisely realised in the behaviour of the chromosomes. And no phenomenon which emerges from breed-experiment more clearly emphasises the correspondence than that of sex-linked inheritance referred to at the beginning of this article. Of the four pairs of chromosomes in Drosophila, one pair is rod-like and equal in the female (xx) but unequal in the male (xy). When the chromosomes pair before the reduction division that separates whole chromosomes, one-half the sperms receive the X and one-half the Y element. All the eggs, on the other hand, receive an X chromosome. An egg fertilised by sperm containing the Y chromosome will have the XY constitution of the male. An egg fertilised by the X type of sperm will have the XX constitution of the female. Thus femaleness is associated with the presence of the X chromosome in duplicate. But we have already seen that the sex-linked factors are represented in structural units which are present in duplicate in the female only. All the results of breeding experiments in Drosophila coincide with the assumption that the X chromosome alone is capable of bearing the sex-linked factors such as that which determines the red-eye.

Sex-link Factors.

The precision with which the distribution of the X chromosomes and sex-linked factors coincide is demonstrated in a quite spectacular manner by the study of a number of abnormal cases of which the analysis is due to the work of Bridges (1914). There appeared among the white-eyed mutant strains of Drosophila a number of abnormal females, which, when crossed with red-eyed males, gave white-eyed females and red-eyed males in addition to the normal types resulting from such a cross, namely, red-eyed females and white-eyed males. When these F1 white-eyed females were back-crossed to red-eyed males they again gave all four classes, namely, white-eyed females behaving in a similar abnormal fashion, red-eyed females some of which gave normal and some exceptional results in crossing, red-eyed males which bred in a normal manner, and white-eyed males, some of which bred in the usual way and some of which produced daughters whose progeny were exceptional.

Bridges found occasional white-eyed females whose dividing nuclei displayed a Y element in addition to the XX pair. This is explicable on the assumption that at reduction of the eggs the XX pair in exceptional cases fail to disjoin, so that the ripe eggs contain either two X or no X chromosomes. Ordinarily, an egg fertilised by a Y-bearing sperm becomes a

male, while an egg fertilised by an X-bearing sperm becomes a female; but an exceptional XX egg fertilised by a Y sperm would be a female (XXY), and an exceptional egg without an X chromosome fertilised by an X sperm would give a male (XO). Hence if, as in a cross with a red-eyed male, the X element of the father alone brought in the red factor occasional white females and red males would be expected. Cytological (i.e., microscopic) evidence shews that these white-eyed females which occasionally turn up in crosses between red-eyed males and white-eyed females are actually the XXY type. Now consider the result of back-crossing such an exceptional white female to a normal red-eyed male. It will facilitate explanation to represent the sex chromosome of the father as X, since it alone bears the red-eye factor. According to whether the X elements segregate with respect to one another or the Y chromosome, these F1 white-eyed females will form four types of eggs, XX, XY, Y only, and X only. The red-eyed normal male forms sperms with X (bearing the red-eyed factor), and Y (without red factor) respectively. The four types of eggs fertilised by a Y sperm will give four types of individuals: (*a*) XXY white females, which will behave in the same way as their mothers; (*b*) XYY white males, producing XY as well as X and Y sperm, hence producing XXY daughters, which will have exceptional progeny; (*c*) YY neuters (die); (*d*) XY normal white-eyed males. The same series of eggs fertilised by an X sperm bringing in the red-eye factor give: (*a*) XXX red-eyed females which usually die in infancy; (*b*) XXY red-eyed females with abnormal types of offspring; (*c*) XY normal red-eyed males; (*d*) XX normal red-eyed females. Thus the non-disjunction of the X chromosome in the formation of the eggs of some of the females of the parental white-eyed stock accounts for the entire series of exceptional genetic phenomena which occur in these strains.

We cannot go into the evidence derived from animals and plants other than Drosophila to indicate the light that microscopic investigation sheds on the result of Mendelian analysis. For a discussion of the present status of the Evolutionary Hypothesis we are above all concerned to ascertain how far the factorial hypothesis gives a satisfactory account of the immense variety of hereditable characteristics. Of the remarkable diversity of anatomical features whose inheritance can be interpretated on this basis the examples already cited will give an indication albeit an inadequate one. One category of phenomena which has provided some difficulty is the question of size inheritance. Sometimes differences in size, e.g., the tall and dwarf strains of the common pea and the length of the wing in Drosophila depend on a difference affecting one pair of genes. More often the results can only be interpreted on the assumption that an immense number of factor differences are concerned. Fortunately as such cases are carefully studied (see East and Jones "Inbreeding and Outbreeding") it is increasingly evident that such an assumption is not gratuitous. For while the most direct test of Mendelian segregation is the possibility of reclaiming the pure parental types in the F2 generation, mathematical analysis reveals other consequences of the hypothesis. One such will be readily appreciated. Suppose we take two strains of tobacco plant differing say with respect to the average length of the stalk and by prolonged inbreeding presumably pure for the difference in question. Each strain may have a characteristic average but the values for a population of the two might form a continuous series. If the parent stocks were pure the F1 must be homozygous and any variability be non-germinal. Clearly if segregation occurs the variability of the F2 generation will always be greater than the variability in the F1. This has in a very large number of cases been shewn to be realised in fact (as we shall see in the next article).

Inheritance.

Here, lest we should appear to be accumulating gratuitous hypotheses, we must pause to consider the way in which the study of linkage has broadened our definitions. Our first definition of a gene was a construction to interpret segregation, i.e., the possibility of reclaiming our original parental types in the second generation of a cross. Just as we originally gave matter an atomic structure to interpret the laws of constant and multiple proportions in chemistry, so we conceived the hereditary substance of the organism an "atomic" structure to account for the constant reappearance of hereditable characters. When we passed on to consider how the inheritance of one character was influenced by the inheritance of another, we found that some characters were inherited independently and others tended to be transmitted together either invariably or in defined numerical proportions expressed by the "cross-over value." We thus find that we are now able to define a gene in terms not merely of a particular character difference but its relation to other genes. Thus there are three flies with black bodies recessive to gray in Drosophila, but the gene responsible for the black colour (black, ebony, sable) in the three cases respectively shew definite and constant linkage relations to the genes responsible for other body characters (e.g. vestigial and long-winged). Or to take another instance,

Vermilion and Red-eye are characters very closely similar in Drosophila, which depend on factors in the same chromosome, but display different cross-over values with reference to other genes. Two genes may be indistinguishable in their bodily expression but the justifiability of the distinction is perfectly clear. Since it can be defined with numerical precision in terms of their influence on the transmission of other characters.

To appreciate the validity of this extension of our criteria it is necessary to mention an important conclusion derived from Morgan's work on Drosophila. It may be taken as a fairly safe rule that the foremost concern of the experimental biologist should be to obtain the right animal for the particular problem he is concerned with solving. For the study of inheritance the fruit-fly is ideal for a large number of reasons. It is prolific, it is easily cultured in glass tubes with a little yeast and banana; it passes through its life cycle in less than a fortnight, so that four hundred generations can be bred in the time which it takes the human offspring to reach sex maturity; finally, it has an extremely small number of highly individualised chromosomes. Several hundred true breeding sports or mutants have appeared in Morgan's cultures since 1912 and the combined efforts of a growing school of American workers during the past ten years have made it possible to work out the numerical linkage relations of this enormous number of mutant genes. Not the least remarkable result of their researches is the fact that a linear relation exists between the crossing-over percentages for different linked genes. Thus if Aa and Bb have a cross-over value 3 per cent. while Bb and Cc have a cross-over value 7 per cent., then if Dd have a cross-over value of 5 per cent with reference to Cc and 12 per cent. with reference to Bb it will also give 15 per cent. cross-over with reference to Aa.

Having thus broadened our definition of the gene to define it not merely qualitatively with reference to a particular character, but quantitatively with reference to the way in which such a character is transmitted with reference to any other transmissible character, we must finally consider a peculiar series of apparent anomalies in breeding experiment which have led to one of the most important extensions of the Mendelian hypothesis, the conception of the "lethal" factor. The simplest case is that of the lethal factor which is sex-linked. One finds certain females in Drosophila which give a two to one ratio of females and males among their offspring. If we assume that such females carry a single complement of a recessive factor which in the homozygous condition prevents the survival of the organism, it follows that no males which receive the X chromosome bearing the lethal factor can survive; since the single X chromosome of the male is not compensated by another X bearing the normal allelomorph. This interpretation of the facts is not an explanation ad hoc to evade a difficulty. The peculiarity of producing a 2 : 1 sex ratio is a physiological character as definitely transmissible as any anatomical property; females which give 2 : 1 sex ratios produce daughters half of whom have the same idiosyncrasy. Thus we can apply the criterion of crossing over with reference to other sex-linked genes; the results justify the assumption of the "lethal" factor. In general lethal factors, which—as we shall see later—are of great importance to evolutionary theory, may be defined as genes which prevent the survival of an organism, and are recognised by the disturbances occasioned by their presence in Mendelian ratios which involve factors to which they are linked.

Books Received.

The Philosophy of Music. WILLIAM POLE, F.R.S., Mus. Doc. Oxen. Kegan Paul, 10s. 6d. net.

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Book Reviews

Roman York. By Gordon Home. (Ernest Benn Ltd., 12*s.* 6*d.* net).

The best type of book on archæological research is the rare volume where one finds not the dry bones of the past, but a vivid living reconstruction of a bygone day.

Mr. Home has rebuilt for us a very real presentment of the Eboracum of Roman times and in place of dealing only with the facts and inferences to be drawn from local discoveries he has pieced together the whole in relation to what is known of the general history of the Roman Empire during the period surveyed.

York was essentially a military centre, nothing less than the advanced base from which all the operations against the Brigantes, the Picts and the northerly barbarians were conducted. It is still a garrison town and a strategic centre of considerable importance despite the passage of nineteen centuries. In Roman times it was the very heart of the frontier system commanding the northerly routes flanking the Pennines.

Occupied in A.D. 71, Eboracum, even then a town of importance, probably the capital of Brigantia, became first a camp of the military invaders and from a fortified camp developed swiftly into a true fort. In less than ten years other forts all admirably sited had been established and with their communications secured, the conquerors marched north into Scotland.

Roman soldiers used the spade no less effectively than the sword, and the success of the imperial arms was probably due as much to skill in military engineering and organisation as to superior armament or discipline.

Then about A.D. 120 an entirely unexplained "regrettable incident" occurred. History is silent but somehow or other York fell and the whole of the IXth Legion were wiped out. Whether the Legion fell in the defence of the fort or were ambushed in the Pennines or across the Scots border is not known. On receipt of the news the Emperor Hadrian acted at once. Reinforcements were despatched, landed in the south and marched north into the rebellious area. Others possibly landed direct and in four years from the overthrow of the fort the great Hadrian's Wall had been erected from Bowness to Tynemouth as a permanent defence to protect the province from the attacks of the barbarians. For some twenty-five years sporadic fighting continued, but from 155 to 284 peace, progress and prosperity reigned.

During this period York developed into a centre of Anglo-Roman culture, but a new danger—sea-power, the raiding fleets of Franks and Saxons now made their appearance. Fifty years later the first serious raid, a combination of sea attack with the support of the tribes beyond the Wall broke through or out-flanked the defences. In 368 the long threatened invasion occurred, the defence collapsed and the tribes either sacked or invested York and ravaged all England south to the Thames.

Rome sent reinforcements, London was relieved and under Theodosius Britain was once more "cleaned up" while naval operations destroyed the enemy's sea base in the Orkneys. Peace lasted for a few years but attacks were renewed. Then somewhere about A.D. 401 a frontier Legion was needed for service on the Italian home-front threatened by the Visi-Goths. These reinforcements went—and we know not how or when, but the weakened colony could not withstand attack and Britain once again relapsed into barbarism after enjoying civilisation for four hundred years.

In all this history, York was the base of operations and four centuries have left their record not only in the remains of the great walled camp but in the altars, monuments, and even potsherds of the citizens. Every fragmentary remain discovered is useful in throwing light on the many dark problems connected with the early history of the city and it is not until one reads a book as illuminating as Mr. Home's that one realises how a seemingly unimportant inscription or a casual coin may be of vital importance. We join with him in his hope that public support will be forthcoming for further excavation on such promising ground.

Time Measurement. By L. Bolton, M.A. (G. Bell and Sons Ltd., 6*s.* net).

A simple readable book on Time giving some space to the mechanics of clocks and watches yet requiring no previous mechanical or astronomical knowledge. It fills a gap and will be welcomed as a stepping-stone to further knowledge of an important subject.

The descriptions of the earliest British clocks and the general evolution of the modern timepiece are clear and interesting. As a suggestion to the author it seems more than probable that the name "*cock*" given to a limb in the striking mechanism is not directly derived from a fancied resemblance to a bird's head but to the "cock" or "serpentin" of a matchlock which it resembles mechanically as well as in outline. Similarly the derivation of the name "*stack-freed*" for an auxiliary spring may be allied to the term *stecher* which means a hair trigger, a device by which an auxiliary spring previously compressed is called into action to release the lock-spring of a wheelock. As Augsburg and Nuremburg were both centres for armourers as well as clock-makers the mechanics and metal-workers may have used the terms of one craft applied to another.

Laboratory Experiments in Practical Physics. By N. Henry Black, A.M. (Macmillan and Co. Ltd., 4*s.* 6*d.* net).

A concise demonstrators' manual written as a supplement to the standard Practical Physics by the same author. It differs from many other works of the same class in that it introduces practical tests in which simple commercial instruments such as tyre pressure gauges, small transformers and even the humble gas ring cooker are introduced. A valuable feature are the essentially American "quizzes," questions or problems on points of importance connected with each experiment.

The Chemistry of Rubber. By B. D. W. Luff, F.I.C. (Ernest Benn Ltd.).

Rubber as a natural product enters increasingly into all kinds of applications in our ordinary life. It is such a familiar thing to us that it is rather a surprise to learn that until comparatively recent years manufacture was mainly on empirical lines and that scientific research had been little utilised to direct and improve manufacturing methods.

The title of the book hardly conveys the width of its scope for not only is the chemistry of rubber comprehensively surveyed but the author gives a clear explanatory account of the whole history of rubber from the different methods of later collections on the plantations and enables is to follow not only the chemical changes but the actual manufacturing processes which the material undergoes until it reaches the market in the form of manufactured goods.

The testing of rubber at various stages of its manufacture is very clearly explained and the use of organic accelerators, fillings and pigments used in manufacturing processes is thoroughly discussed from both the physical and the chemical point of view.

Mr. Luff is to be congratulated on having brought together in one admirable volume a very complete survey of the whole subject. The book is excellently produced, well illustrated and amply documented with references to the existing literature of the subject from English, German and other sources. The only point that might reasonably rouse objection is that no space is devoted to the important Peachey process of cold vulcanisation.

The Atom and the Bohr Theory of its Structure. By H. Holst and H. A. Kramers. (Gyldendal, 10*s.* 6*d.* net).

The Bohr theory of atomic structure although not yet entirely accepted with all the finality the authors seem to desire is yet one of the most progressive ideas in contemporary physics. This book has been written as an elementary presentation of the theory and has been extraordinarily ably translated from the Danish by Mr. and Mrs. Lindsay.

Sir Ernest Rutherford who has contributed a short introduction says of it "I can confidentally recommend this book to English readers as a clearly written and accurate account of the development of our ideas on atomic structure. It is written in simple language, and the essential ideas are explained without the mathematical calculations. This book should prove attractive not only to the general scientific reader, but also to the student who wishes to gain a broad general idea of this subject before entering into details of the mathematical theory."

So much for its orthodox scientific bill of health. The question remains is it a book that can be read and understood by the ordinary man whose equipment of scientific knowledge is below the standard of a scientific reader familiar with recent progress? The answer is—yes. It is a book which can be confidently recommended for in simple language it covers the whole field from the earliest conception of the theory of atoms. Light waves and the spectrum, ions, electrons and the nuclear atom are all passed progressively under review and the quantum theory explained with admirable clarity, so that the reader who is assumed by the authors to have no previous knowledge is led step by step to a very full realisation of the value of the Bohr theory in giving the most comprehensive view of atomic structure we have yet attained.

Apart from its value to the ordinary reader the book is valuable to all scientists who require a sound general review of the assault on the atom as seen from the Bohr sector of the front.

The Geology of Metalliferous Deposits. By R. H. Rastall, Sc.D., M.Inst.M.M. (Cambridge University Press, 21*s.* net).

Those members of the British Association who are attending this year's meeting in Canada will find that the dominant scientific interest of the Canadian public is centred on the metalliferous deposits of Ontario and Quebec.

In Great Britain relatively few people except mining engineers and a very few financial groups realise that the great mineral belt of Canada is becoming another Rand and that some of the largest producing gold and silver mines are already in existence there.

This latest volume of the Cambridge Geological series can be cordially recommended for a clear account of the basic theories of the general principles underlying the formation of ore deposits and secondly for the excellent manner in which in the second section of the work each individual metal of importance is dealt with.

Scientific men or general readers who may not be familiar with the latest theories of geology as applied to minerals will find the work invaluable. Experts will accept it as a standard of authority not likely to be surpassed for many years.

Ultimatum. By Victor Maclure. (George G. Harrap, 7*s* 6*d.* net).

The pseudo-scientific novel is often a source of pleasurable entertainment. One can either accept preposterous rays and new elements and enjoy the tale as a tale, or one can sit down, assume a superior manner and revel in the joys of a fireside hunt for impossibilities, errors and general heresies. In any case you get value for money.

Victor McClure has made a very plucky attempt to make some kind of elementary explanation of the modern theory of atomic structure the action basis of a modern novel. He presents us with a "League of the Covenant" headed by a mysterious super-physicist who has fortunately stumbled across a secret volcanic area where pure radium in its metallic state, natural helium gas and a few odds and ends such as a new unknown anæsthetising gas and *aithon* a new lighter than hydrogen gas with no valence and a satisfied system are available.

Thanks to these resources and his wonderful brain The Master is able to equip a pirate airship which raids New York, Paris, London, Berlin and other places, putting the inhabitants to sleep while his merry men rob the banks of their gold supplies and destroy all bonds and securities.

True to the Robin Hood tradition they leave in return vast boxes of pure radium for the use of the hospitals. The Master is, however, no mere bandit. His object is to make warfare impossible and force all nations into a League for Peace—whether they like it or not. His beneficent depredations paralyse civilised commerce and eventually his attack on Washington obliges the United States to surrender and call a World Conference of statesmen and scientists who are obliged to accept his terms. Absolute disarmament is insisted on and agreed to.

The book bristles with alluring Jules Vernian technicalities but the blending of fact, physics and fiction hardly runs smoothly enough and the book is badly blemished by colloquial Americanisms. As novels go, it contains more ideas to the chapter than most hold from cover to cover and even if the author does not quite succeed in carrying conviction to the reader it is no mean task he has attempted and we shall look forward to his next book with interest.

Wireless Telephony, A Simplified Explanation. By R. B. Bangay. (The Wireless Press Ltd., 2*s.* 6*d.* net).

This is an extraordinarily good little book for it combines sound scientific instruction with a happy capacity for simple explanation and easily grasped illustration. Since the birth of broadcasting wireless telephony handbooks have been plentiful and as a rule very mediocre compilations. The glib and catalogue consuming schoolboy has been able to amass a wealth of information concerning the relative values of different makes of instruments and the virtues or failings of components. He can argue at second-hand on freak circuits but when all is said he has not as a rule gathered much of real value concerning the fundamental principles involved.

Bangay deals not with apparatus but with principles. He handles the difficult problem of explaining such matters as wave transmission and electrical resonance so that the man in the

street can get, not simply a vague idea but a well established grasp of the 'reasons why.' It is admittedly a popular handbook at a popular price but its timeliness and its very real value make it into one of those books which have a genuine educative value and open the way to successful understanding of the many intricate and technical branches of knowledge, whose practical application is for the moment most popularly recognised in wireless telephony.

The amateur wireless constructor, whatever his age, will get sound value out of this book and parents and teachers will find it invaluable as a means of converting juvenile interest in the technicalities of amateur wireless reception into something of genuine value. In fact, if a boy is made to read the book and then shows that he has obtained a genuine grasp of the principles behind wireless he may then be said to have reached the stage where as a reward he should be allowed to build a receiving set.

Time and Weather by Wireless. By W. G. MITCHELL, B.Sc., F.R.A.S., F.R.Met.S. (The Wireless Press Ltd., 3*s.* 6*d.* net).

Weather, which used to be unpredictable except by coast-guards is rapidly being robbed of some of its worst surprises. A decade ago one turned to the Greek lady of the *Daily Graphic* or the close set type of the heavier dailies and read the forecast without any particular hope that it would turn out to be right. To-day the most conservative people, farmers, country gentlefolk and the like listen-in at 9.30 p.m. for what is to them the most important factor in the broadcasting service. They discount the isobars and the depressions but they set their clocks by Greenwich and they apply the warnings of frosts or impending rain to the needs of their crops.

The author presents in his book a very complete survey of how the weather reports are gathered in by wireless from all parts of Europe and traces the modern development of the meteorological service and its general increasing utility. The scientific reader will probably be more interested in the chapters on the transmission of time signals, both 9 m.t. and sidereal time by rhythmic beats and the descriptions of the transmitting mechanism employed. Owners of wireless receiving sets who are able to read slow Morse will find a new interest opened to them

The Carbon Compounds : A Textbook of Organic Chemistry. By PROF. C. W. PORTER. (Ginn and Co., 21*s.*).

A Treatise on Light. By R. A. HOUSTOUN, D.Sc., Ph.D. New Edition. (Longmans, Green and Co., 12*s.* 6*d.*).

Electricity and Magnetism for Advanced Students. By S. G. STARLING, B.Sc., F.Inst.P. Fourth Edition. (Longmans, Green and Co., 12*s.* 6*d.*).

The Mechanical Properties of Fluids. A Collection of Work by various Authors. (Blackie and Son, Ltd., 20*s.*).

The general level of scientific books issued since the war has been high and continues high. It is hard to explain this except on two grounds ; one, that the present-day student is, in general, a person well worth writing for, and the other, that the text-book writer is putting his back into his work as he never did before. The four books before us, written avowedly for advanced students, selected from others hardly inferior in merit, are examples of this high level. Each of them in its way is very good.

Prof. Porter's book is American in the best sense ; it is informed and up-to-date and bears throughout the marks of an original teacher. It is a book that a student in his second and third year at College would find useful. It is not likely to supplant the standard text-books on organic chemistry on this side of the Atlantic—" Perkin and Vipping," " Small Cohen," " Big Cohen "—but it is a book that will refresh students who read it. It has three main divisions. The aliphatic compounds come first and then, quite separately, the aromatic compounds ; lastly there follows a review of the more important general organic reactions. Problems of physiological and of bio-chemistry are discussed more fully than in books of this class and theory receives its fair share of attention. Indeed Prof. Porter has the hardihood (and the wisdom) to start off chapter I by talking about electrons and he keeps the modern point of view throughout.

Dr. Houston's book on *Light* is now in its third edition and is becoming popular. It covers adequately the course that an informed student of the subject should read if he wishes really to get into the matter. The supplementary chapter dealing with new discoveries is rather short and sketchy and might well be expanded in a subsequent reprint. Of course, " the very latest " need not be emphasised unduly. Light, as a science, existed and even had an honourable record before 1910. Dr. Houston is against those people who believe that every science needs rewriting in the light of the very latest discoveries, and in chapter 21 he shows, and apparently convincingly, that the orthodox theory permits of light being propagated in pulses and of the dispersion and interference of such pulses.

Mr. Starling's book is now an up-to-date compilation which will continue to be found useful by " advanced " students. The new matter in the present edition includes an account of radio-activity brought up-to-date, and accounts of the positive-ray analysis of elements and of the modern theory of the atom. Those of us who were bored by the banalities of electrostatics and influence-machines in our student-days must envy the modern student who can offset such dreadful subjects by reading about Bragg's work on X-rays and crystal structure, about Millikan's cloud experiment, or C. T. R. Wilson's work on tracking the α-particle, or Aston's work on Isotopes. To-day is indeed the Heroic Age in Physics.

The Mechanical Properties of Fluids is a collection of essays describing recent research on, and modern points of view relating to, this important subject—information of practical importance to the physicist and engineer. Prof. Lamb writes on the mathematical theory of fluid motion, Mr. Michell on viscosity and lubrication, Dr. Geddes on wind structure (has wind a structure !), Mr. G. I. Taylor on the determination of stress by means of soap films, and Dr. Drysdale on submarine signalling and the transmission of sound through water, and Prof. Gibson on stream-line motion. This book contains the information that one longs to see in an encyclopædia—in the ideal encyclopædia that has the right contributors and which is published before its information has become out-of-date.

" Man's Mental Evolution." By HARRY CAMPBELL, M.D. (Bailliere, Tindall and Cox, 1923, pp. vii. + 74. Price 3/6.)

The aim of this little book is to trace the evolution of the mind of man, to consider the factors that are at present influencing it and " to attempt to forecast " Man's " Mental History."

A considerable amount of intellectual courage is required to attempt so vast a project, and the author is dauntless enough to compress it within the narrow compass of 74 pages. The result is a book of attractive, architectural simplicity, whose stability is only impaired by the doubtful solidity of much of the frame-work.

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